# POWER

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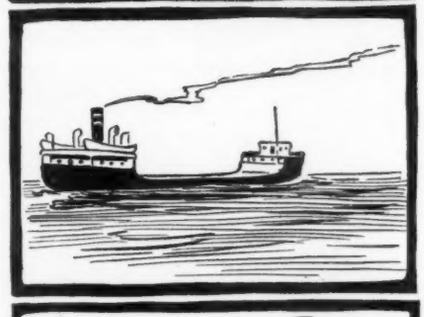

# Purposeful Anecdotes

A true plain story of the success of a plugger—to encourage those who think only the gifted or lucky win out.

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## A Life Story

**HERE is the condensed history of an engineer. With self-respect and a little determination, so he declares, anyone can do as well or better.**

**He was taken from school before he was 10 years old. For five years he worked at plumbing, but did not like it. Then he worked four years at steam and hot-water heating, attending night school during two of these years.**

**Next, he became an assistant engineer on a lake steamer. At this time he started to study engineering books and journals. At 21 years he secured a situation as an apprentice in a large factory.**

**Next, he was the engineer in a large modern hotel, after which he went with the Canadian General Electric Co. as trouble man in its Peterboro works. The Ontario Government offered him a situation as stationary engineer, and he accepted.**

**At present he holds a position with the Canadian Government as chief engineer in a large plant and has a staff of sixteen men. Incidentally, he has received altogether several hundred dollars in the past few years for contributions on engineering, etc., to technical papers. He describes himself as only an ordinary man, by no means smart or clever, but he is temperate and has never been afraid to do a little extra work with no extra pay.**

**He has been down-hearted more than once and even wrote to Power for advice some years ago and he received encouragement in reply. Power has this engineer's address.**

# Norfolk & Western Electrification

*SYNOPSIS—Power for the electrified section of 30 miles is supplied by a 30,000-kw. steam plant at Bluestone Junction and five substations. Generation is at 11,000 volts three-phase, transmission at 44,000 volts single-phase and the trolley voltage 11,000 single-phase; step-down transformers and phase-converters on the locomotives transform the current for use in three-phase induction motors. Regenerative braking is employed.*

The electrified section of the Norfolk & Western Ry., known as the Elkhorn grade, is located on the main line in the southern part of West Virginia and extends from Bluefield to Vivian, a distance of about 30 miles. This is a switching and short-haul division between the coal fields and Bluefield, operated to a large extent independently of the other traffic on the main division. In addition to the heavy-tonnage coal-train service, however, freight and passenger traffic over this section is also handled in part by electric locomotives, which are used as pushers on the steep grades. The purpose in electrifying this section was to increase the capacity by materially reducing the time required to handle traffic and to provide a more economical and efficient service over the heavy grades. The heavy freight trains are handled with electric locomotives at a running speed up the grades of 14 miles per hour, as compared with 7½ miles under steam operation. Further saving in time is effected by the elimination of the delays occasioned by the steam engines occupying the tracks while taking on coal and water at several places on the grades. Moreover, one electric engine takes the place of two Mallet steam locomotives over the division, or two electric engines take the place of three Mallets up the grades and at practically double the speed.

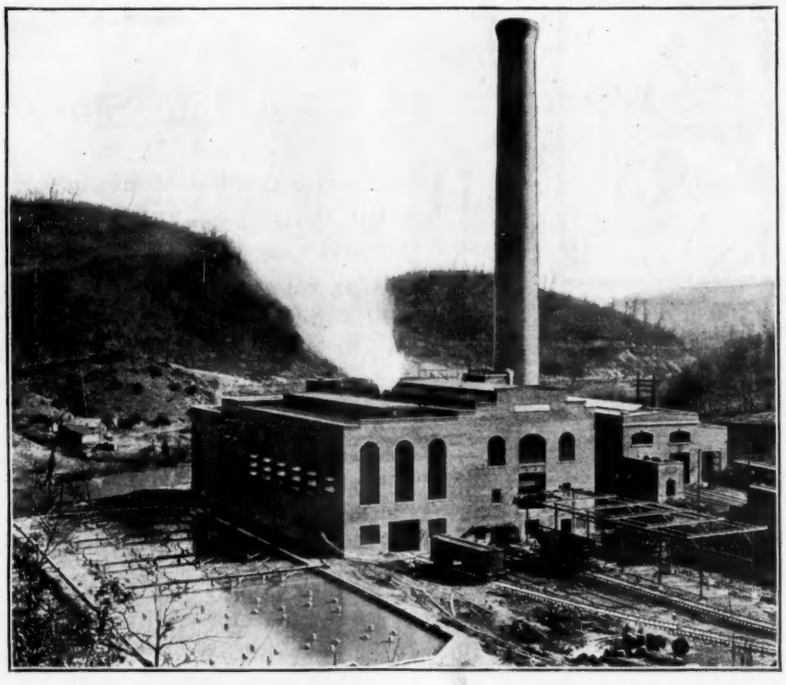


FIG. 1. POWER-PLANT BUILDING AND SPRAY POND

The transmission and distribution system is single-phase at 25 cycles, and power is collected from the overhead catenary at 11,000 volts. The locomotives, however, are equipped with phase-converters which, in connection with step-down transformers, change the single-phase current of the trolley to three-phase for use in the three-phase induction-type traction motors. Thus, while retaining all the advantages of high-voltage, single-phase distribution and collection, the advantages of three-phase induction motors for the heavy traction service is also secured.

Another important feature of the employment of polyphase induction motors for traction is the electric braking of the trains at constant speed while descending grades. This not only utilizes the energy of the moving trains to drive the motors as generators and thus return energy to the line, but also permits the heaviest train to be handled down the mountain grades with a single engine at a uniform speed of about 15 miles per hour, while the air brakes are held in reserve for bringing the train to a standstill when necessary.

## THE POWER STATION

The power station was located at Bluestone, on the Bluestone River, mainly for the reason that this is practically the only available source of water for boiler feed and condensing purposes in the district, and the company had already constructed a dam and reservoir here for the water supply for the steam locomotives. The main building contains a boiler room 79x158½ ft., and a turbine room 56x158½ ft. Across the east end of the latter a section 26 ft. wide is assigned for the switching equipment, offices and other facilities and is fitted with intermediate floors and galleries. On the main floor is the low-tension switching room, separated from the turbine room by a heavy wire screen; the next floor is the operating gallery overlooking the turbine room. On the ground floor of the extension building are the step-up and step-down transformers, and on the second floor is located the high-tension switching apparatus.

## COAL AND ASH HANDLING

Coal is received in hopper-bottom cars on a siding along the south side of the station, the cars discharging into a steel hopper under the track. Below the hopper is a single-roll crusher which empties into an inclined conveyor of the bucket type having a capacity of about 60 tons per hour, at a speed of 80 ft. per min. This elevates the coal to a hopper at the east end of the boiler-room monitor, and from this hopper the coal is fed to a horizontal distributing conveyor extending longitudinally

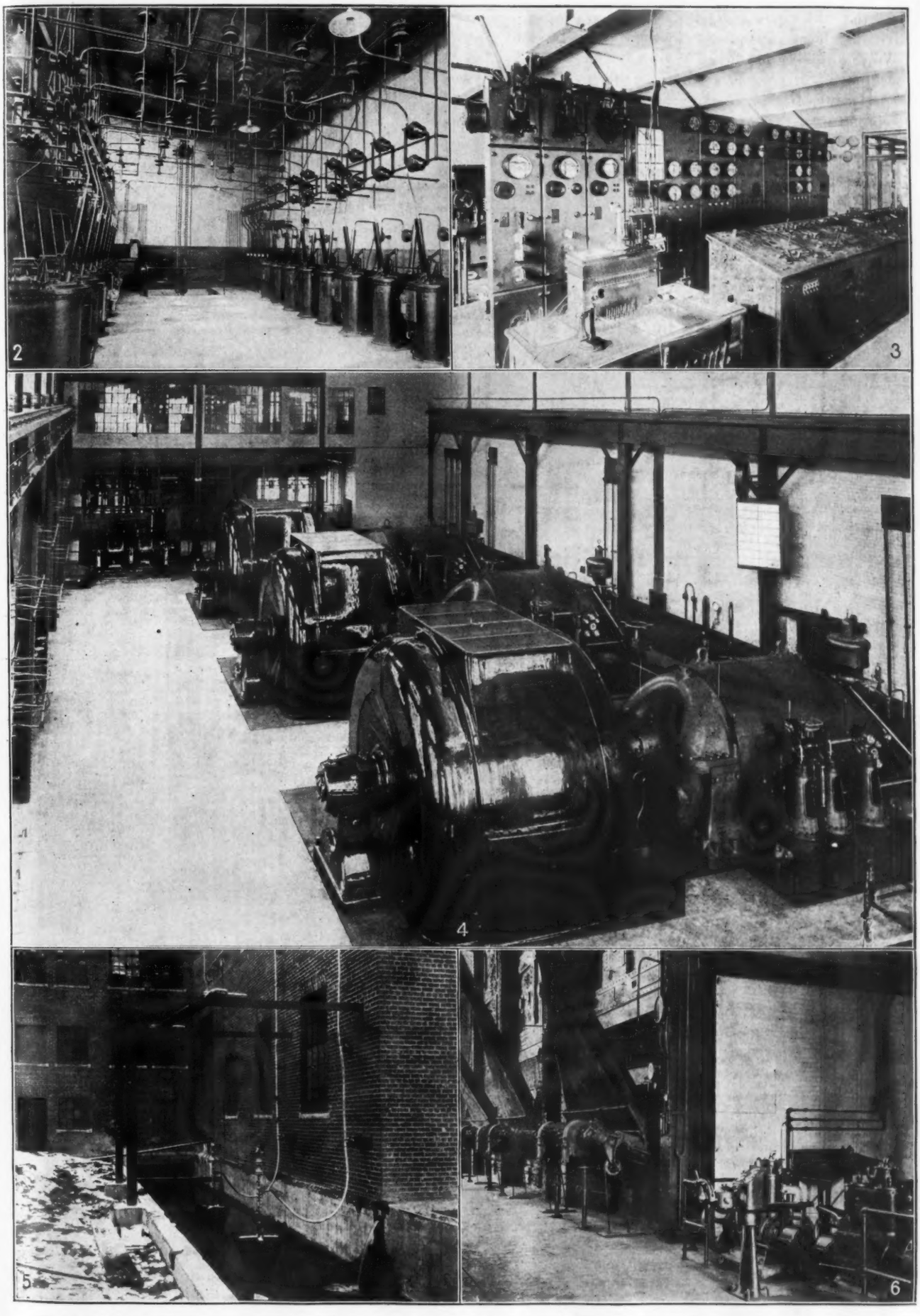


FIG. 2. HIGH-TENSION SWITCHING ROOM. FIG. 3. CONTROL BOARD. FIG. 4. TURBINE ROOM. FIG. 5. REGENERATED POWER LOADING RHEOSTATS. FIG. 6. ONE SIDE OF BOILER ROOM

over the boiler room. Coal is distributed by means of nine handwheel-operated gates to two storage bins having a capacity of about 350 tons. The coal-handling machinery is driven by alternating-current motors.

Ashes are discharged through the ashpit hoppers to steel platform cars each carrying two 1-cu.yd. buckets. These are run outside the boiler-room basement to a loading trolley, the buckets being lifted from the platform cars and emptied into gondolas by means of a traveling electric hoist. The hoist motors are 220-volt direct current.

### Boilers and Stokers

The boiler plant comprises ten Stirling-type water-tube boilers arranged in two rows with an aisle between. Space is provided for four additional boilers. They are designed for a working pressure of 225 lb. gage and 150 deg. superheat. Each is fitted with an underfeed stoker of sufficient capacity to evaporate 61,000 lb. of water per hour into steam at 200 lb. gage and 150 deg. superheat when supplied with feed water at 200 deg. Each row of stokers is driven by two automatic steam engines, and the stokers are capable of developing 300 per cent. normal boiler rating when burning coal having a heat value of 12,250 B.t.u. Steam from the exhaust header is discharged into two horizontal Cochrane feed-water heaters, each capable of heating 225,000 lb. of water per hour from 40 to 225 deg. F.

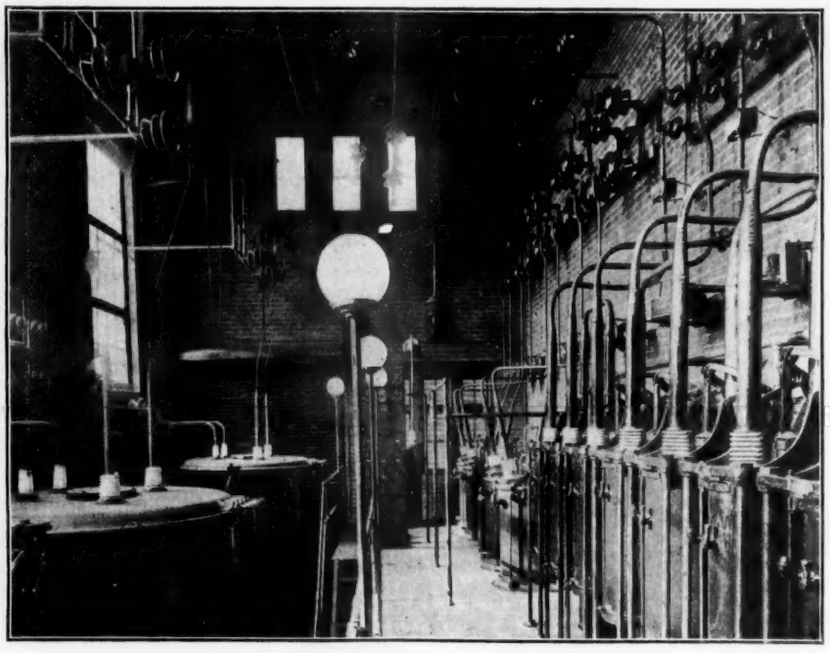


Fig. 7. Interior of Substation

The feed water is taken from the intake canal and pumped to the heaters by two low-head pumps of the horizontal volute single-stage double-suction type having a capacity of 650 gal. per min. against a head of 45 ft. These pumps are driven by 20-hp. steam turbines. From the heaters the water flows to the two boiler-feed pumps which are also of the horizontal volute three-stage double-suction type, designed to operate against a working head of 600 ft. These are driven by 175-hp. steam turbines.

### The Stack Details

The stack is of the radial-brick type, 268 ft. in height, or 250 ft. above the grate, with a minimum inside diameter of 20 ft. A 4-in. brick lining extends 75 ft. from the bottom of the flue opening, with a 2-in. air space between the lining and the column.

The forced-draft installation in the boiler-room basement consists of three Sturtevant multivane fans, driven by steam turbines through 4 to 1 herringbone reduction gears. The rated capacity of each fan is 150,000 cu.ft. of free air per minute against a static pressure of 6 in. of water when running at 540 r.p.m.

### Steam-Turbine Equipment

The initial equipment consists of three main generating units with space provided for a fourth. These are of the horizontal Westinghouse type rated at 10,000 kw., with steam at 190 lb. gage and 150 deg. superheat when operating at a 28½-in. vacuum and 1500 r.p.m.

Each turbine is equipped with a Le Blanc condenser, and injection water is taken from the tunnel that runs under the basement floor. The condenser injection water and air pumps are driven by a horizontal turbine. The air pump discharges into the intake canal and the injection pump into a pipe leading to the spray-cooling pond. Each condenser is capable of maintaining a vacuum of 28 in. when condensing 145,000 lb. of steam per hour, with cooling water at 70 deg. F. The exhaust steam from the turbines driving the condenser pump is automatically admitted to the main turbines when the supply of exhaust steam is more than is required for feed-water heating. The water from the circulating pumps of all the condensers is discharged into the cooling pond. If the supply of river water is low and not suitable for boiler use, the water is sprayed into the pond and then discharged into the intake canal. If there is sufficient cold river water of suitable quality, the water from the condensers is not sprayed, but is discharged into the pond, from which it is allowed to flow into the river reservoir several hundred feet below the intake and circulates up the stream to the intake, the complete circuit being about 1400 ft. At the west end of the pond is a sluice gate opening into two 36-in. pipes which discharge into the river some distance below the power station. As the normal level of the river is about 3 ft. below the bottom of the pond, the basin may be drained by the sluice gate if necessary.

### The Steam Piping

The main steam header runs the entire length of the boiler room on the turbine-room side. It is of 12-in. flanged-steel pipe, and is fed by 8-in. lines from the boilers. Each boiler has an automatic nonreturn stop and check valve, and each turbine is fed by a 12-in. line from the header. Expansion is cared for by long radius bends. All straight lengths of main and auxiliary steam

piping are of full-weight wrought steel with van stone extra heavy steel flanges, and all bends and offsets of the main and auxiliary steam lines are of extra heavy steel, the exhaust-steam piping up to 10 in. in diameter being of merchant pipe with standard-weight screwed cast-iron flanges, the bends and offsets of extra heavy pipe and standard-weight cast-iron flanges. All exhaust lines of 12-in. diameter or over are of cast iron with standard-weight fittings.

The piping is covered with 85 per cent. magnesia blocks 1½ in. thick, the smaller live-steam pipes having one layer and the larger ones two layers. The exhaust and low-pressure piping is covered with air-cell sectional blocks of asbestos paper finished with rosin-sized paper and canvas, as in the case of live-steam piping.

### Generator Installation

The main generators have a rating of 10,000 kw. at 80 per cent. power factor, 11,000 volts, 25 cycles, single-phase. At this rating they are specified to operate 24 hours, with a rise in temperature not exceeding 60 deg. C. above the temperature of the cooling air. This temperature rating is used because the load factor and form of the load curve are such that a rating on this basis gives a truer conception of the size of plant required than would be obtained by adhering to the usual temperature basis of rating machines operating on a high load factor. The armatures are wound three-phase, the traction load being taken off one-phase only and the auxiliary motors around the power house running off the three-phase bus. This of course necessitates a much larger machine for the given output, but has certain advantages over the use of single-phase generators.

Each generator is ventilated by a blower with a capacity of 50,000 cu.ft. of air per minute against a static head of 5 in. of water, the fan being driven by a 100-hp., 440-volt, three-phase motor. The blowers are located in the basement.

There are two turbine-driven and one motor-driven exciters. They are compound-wound machines with commutating poles and each has a capacity of 600 amp. at 250 volts. Voltage regulation is effected by a Tirrell regulator.

Power for signal service is applied by two turbine-driven generators, supplying 60-cycle, single-phase, 4400-volt current.

### Turbine Oiling System

Oil is pumped from a Bowser filter to storage tanks having a capacity of 3000 gal. and located 32 ft. above the turbine floor. From the tank it flows by gravity to the turbine oiling system, consisting of a water-cooled reservoir from which the oil is pumped from the governor and the bearings by a gear-driven pump operated from the turbine shaft. The oil is supplied to the governor at a pressure of 45 lb., which is reduced to about 10 lb. by a reducing valve before passing to the bearings. From the bearings it returns to the cooling reservoir.

### Switching Apparatus

The generator leads connect through oil switches with a three-phase, 11,000-volt bus which is sectionalized, three-phase power for the auxiliary services being taken off the island section. Power for the railway service is taken off one phase only, as previously stated. This phase connects with three 5000-kv.-a., 11,000 to 44,000-volt transformers, the secondaries being connected to 44,000 single-phase feeders. The secondaries of these transformers have their middle points grounded through resistance.

No brick or concrete busbar compartments are used. Instead, the bus structure consists of copper tubing carried on insulators mounted on pipe framework. Copper tubing and bare wire are used wherever possible, insulated wire being employed only where the conductors are carried in conduits. All the oil circuit-breakers are

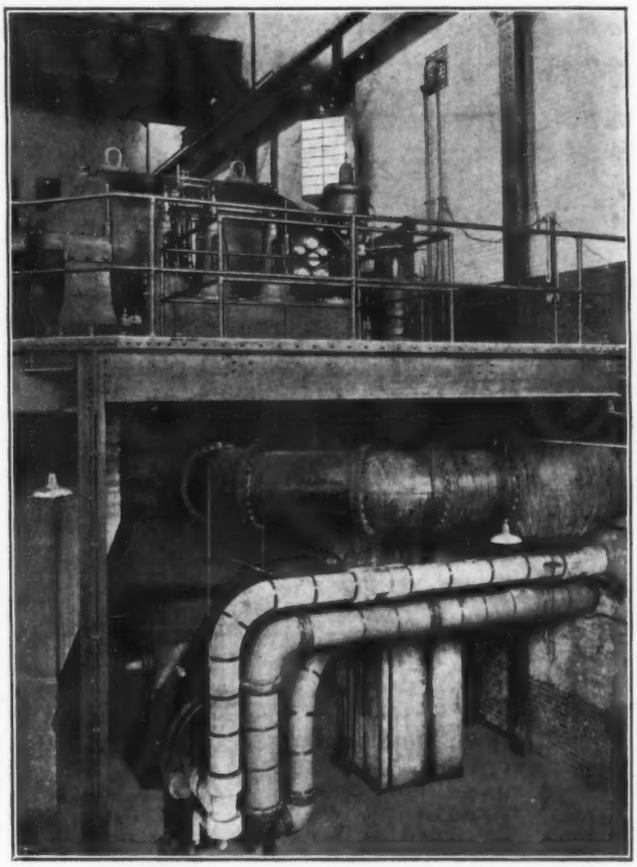


Fig. 8. Le Blanc Condenser under Turbine

electrically controlled from the operating gallery, the control being from the auxiliary direct-current busbars or a storage battery located in the turbine-room basement.

### Regeneration Loading Rheostats

Excess regenerated power returned at no load passes to the 11,000-volt bus and through the various transformers back to the generators if they are running under very light load or no load. If no other load were provided, the regenerated power would reverse the generators and operate them as motors. To prevent this, a loading device consisting of electrodes immersed in the intake canal and controlled by suitable switches, is provided. The operation is automatic by means of a group of relays and magnetic switches, current transformers, etc., so connected that when the amount of excess regenerated power reaches, say 300 kv.-a., the closing relays throw in one water rheostat on the 11,000-volt bus. As soon as the regenerated power exceeds the capacity of one water rheostat by 300 kv.-a., another closing relay throws the second water rheostat in on the 11,000-volt bus. The

difference between the amount of excess regenerated power and the capacity of the water rheostat in service is made up by the generators. When the excess regenerated power has become reduced to zero, with one rheostat in service, all of the rheostatic load being supplied by the generators, one of the tripping relays trips the circuit-breakers and this cuts the rheostat off the 11,000-volt bus. These water rheostats are located outside of the transformer house, as shown in Fig. 5.

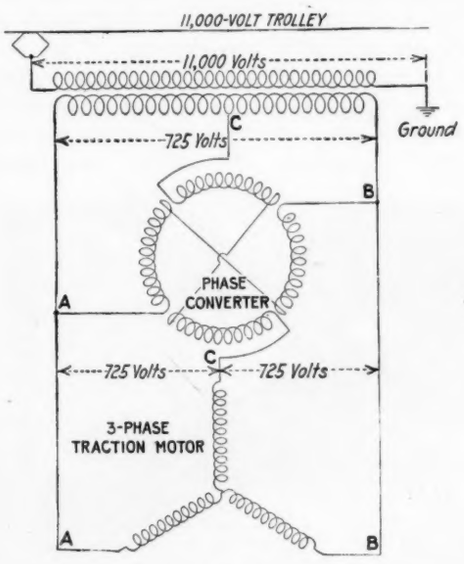



FIG. 9. PHASE-CONVERTER CIRCUIT

## TRANSMISSION AND SUBSTATIONS

As previously mentioned, power is transmitted at 44,000 volts, 25 cycles, single-phase to five substations, where it is stepped down to 11,000 volts. The oil circuit-breakers in the substations are remote-controlled and will be operated from adjacent signal towers or passenger stations or the yardmaster's office, thus requiring no special attendance. The transformers are of the single-phase, oil-insulated, water-cooled type, with primaries wound for 44,000 and secondaries for 11,000 volts, and are equipped with thermostats which, at high temperatures, close a bell-alarm circuit to the nearest operator's office. Two transformer filter outfits have been provided, one for the power house and the other for the substation. Each equipment consists of a filter press, drying oven, and motor-driven centrifugal oil pump.

## LOCOMOTIVE DETAILS

From the 11,000-volt trolley the operating current is taken by a pantagraph and led to the locomotive transformer through an oil circuit-breaker. A phase-converter is connected to the low-tension side of the transformer and operates constantly when the locomotive is in service. To its extended shaft are coupled a blower for cooling the motors, transformer and other parts, and through a clutch, the air compressor. The converter is an induction motor with a short-circuited or cage-wound secondary, having two windings on its stator, one to drive the rotor and the other to furnish current out of phase with the main supply current. The motor circuit of the primary winding of this converter is connected across the secondary of the locomotive transformer and receives current at 725 volts. The arrangement of winding is such that with the converter running, a current of 90-deg. phase displacement is induced in the second winding on the primary of the converter. By connecting this displacement circuit to the middle tap of the main transformer, a three-phase current is produced by the ordinary

PRINCIPAL EQUIPMENT OF NORFOLK & WESTERN RY. ELECTRIFICATION*

| No. | Equipment | Kind | Size | Use | Operating Conditions | Maker |
|---|---|---|---|---|---|---|
| 10 | Boilers | Stirling | 677-hp. | Steam generation | 200-lb. gage, 150 deg. superheat | Babcock & Wilcox Co. |
| 10 | Stokers | Underfeed | | With boilers | Capable of 300 per cent. rating | Westinghouse Machine Co. |
| 1 | Stack | Radial-brick | 268 ft. high. | | | Alphons Custodis Chimney Construction Co. |
| | Flues and ducts | | | Serving boilers | | C. B. Nicholson & Co. |
| 3 | Forced-draft fans | Multivane | 150,000 cu. ft. air per min. | Boiler draft | Turbine-driven; 6-in. water press.; 540 r.p.m. | B. F. Sturtevant Co. |
| 1 | Coal-and ash-handling equipment | | | | | R. H. Beaumont & Co. and Shephard Crane & Hoist Co. |
| 2 | Feed pumps | Horizontal, volute, three-stage | | Boiler feed | 650 gal. per min. against 600-ft. head, 2750 r.p.m. | Westinghouse Machine Co. |
| 2 | Feed pumps | Horizontal, volute, single-stage | | Supply to heater | 650 gal. per min. against 45-ft. head, 1800 r.p.m. | Westinghouse Machine Co. |
| 1 | Heater | Cochrane | | Heating feed water | 225,000 lb. water per hr. from 40 to 205 deg. | Harrison Safety Boiler Works |
| 3 | Turbo-generators | Horizontal, three-phase | 10,000-kv.-a. | Main power units | Steam press. 190 lb., 150 deg. superheat, 28½-in. vac., 1500 r.p.m., 11,000 volts, single-phase for traction service, three-phase for auxiliary service. | Westinghouse Machine Co. and Westinghouse Elec. & Mfg. Co. |
| 3 | Condensers | LeBlanc | | Main turbines | 145,000 lb. steam per hr. with cooling water at 70 deg.—28-in. vac. | Westinghouse Machine Co. |
| 1 | Cooling-pond equipment | Spray | | Condensing water | | Spray Engineering Co. |
| | Steel piping and flanges | | | | | M. W. Kellogg Co. |
| | Pipe fittings | Cast steel | | | | B. F. Shaw Co. |
| | Valves | | | | | Prall & Cady Co. |
| | Cast-iron pipes | | | | | Glamorgan Pipe & Foundry Co. |
| | Pipe covering | | | Heat insulation for piping and flues | | H. W. Johns-Manville Co. |
| 1 | Storage battery | | 160 amp.-hr. | Control equipment | 220 volts | Electric Storage Battery Co. |
| 2 | Exciters | Turbine-driven | 600-amp. | Excitation for main generators | 250 volts, 2200 r.p.m. | Westinghouse Elec. & Mfg. Co. |
| 1 | Exciter | Motor-driven | 600-amp. | Excitation for main generators | 250 volts, 2200 r.p.m. driven by three-phase motor | Westinghouse Elec. & Mfg. Co. |
| 3 | Transformers | Single-phase, oil-insulated water-cooled | 5000-kv.a. | In power house; traction load | 11,000 to 44,000 volts | Westinghouse Elec. & Mfg. Co. |
| | Switching equipment | | | | | Westinghouse Elec. & Mfg. Co. |
| | Power-house wiring | | | | | General Electric Co. |
| 1 | Air compressor | Steam-driven | 412 cu.ft. air per min. | Tools and cleaning | 100 lb. pressure | Chicago Pneumatic Tool Co. |
| 1 | Crane | | | Power house | | Alfred Box & Co. |

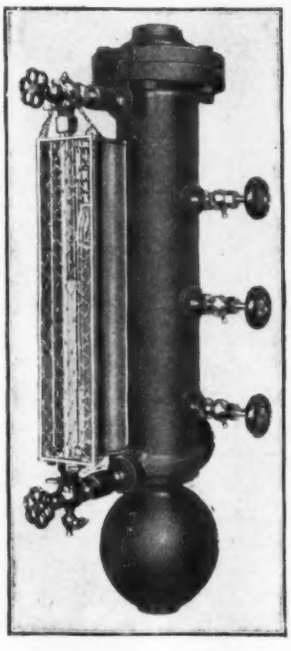
*Substation, line and locomotive equipment not listed.

two-phase and three-phase methods of connection (see Fig. 9). It is necessary only to convert a portion of the current used in the motors, as a large part comes directly from the main transformers. For starting the converter, a single-phase series commutator-type motor is mounted directly on its shaft.

Each locomotive is equipped with eight traction motors of the three-phase induction type with wound secondaries for four-pole and eight-pole operations. There are two running speeds, namely, 14 and 28 miles per hour. In starting, resistance is inserted in the secondary circuit of the motor by means of a liquid rheostat. For the 14-mile speed all the motors are connected in parallel having the eight-pole combination, and for the 28-mile speed they are also connected in parallel, but with the four-pole combination.

## Safe Guard Gage Glass Reflector

In the safe operation of a boiler it is of the greatest importance to be able to see the exact water level, and the more clearly the water line can be seen, the better for all concerned. In this connection the Reordway Manufacturing & Sales Co., of Chicago, has recently perfected a gage-glass reflector and guard which makes the water show red and protects the operator against accident by breakage of the water glass. The device surrounds the gage-glass. It is made of aluminum with a wire-glass front. Within the casing an electric light so reflects on the water as to make it appear red, thus making a positive distinction between that part of the glass containing water and the part containing steam. The water level can be seen from any point in front of the guard and the possibility of a false level due to discoloration of the glass or condensation running down the sides is avoided.



REFLECTOR AND SAFE GUARD

At both the top and bottom of the reflector rubber gaskets prevent the metal from touching the water glass, and as the latter is inclosed, it is maintained at a temperature approaching that of the steam. The glass is not subjected to drafts in the boiler room, and the strains due to expansion or construction are obviated to such an extent that breakage is less frequent. Even if breakage should occur, the aluminum casing and the wire-glass cover protect the fireman from any serious injury. The reflector is made to fit any standard water-gage glass and is easily applied.

**Railroad Expenditures**—The average expenditure of one of the leading Eastern railroad systems every time the clock ticks off a minute, is $191.63 for supplies. In a year it buys $100,722,006 worth of material of such wide diversity as coal and soft soap, ink and feather dusters, steel and paint.

## JUST FOR FUN

### Getting a High Vacuum

The engineer was summoned to the office upstairs to see what was wrong with the radiator. Though it was a vacuum system, the radiators were full of water, which indicated stoppage in the return line. After examining all valves on the return line back to the boiler room, he went to the vacuum pump. Sure, there was 25 in. of vacuum, and the pump was running free and easy, but the valve on the suction pipe was closed. The fireman stated he could not keep a good vacuum on the gage with the suction valve open, so he closed it and used a little more city water on the spray jet and held up the vacuum beautifully.—*R. A. Cultra, Cambridge, Mass.*

### Imported for a Purpose

The inclosed clipping is from a recent issue of an English magazine. The unknown professor mentioned in the advertisement has evidently copied his idea from his American brother faker, but he has put in a few new points which are about as funny as anything I have ever seen in an advertisement. He tells prospective customers that coal ore improves on nature by making the coal give out just as much heat as usual, but that the coal will burn just twice as long as usual.

SCIENCE VERSUS NATURE

**Science has demonstrated how it can triumph over nature, for here is a product of mankind which actually improves nature and makes coal give out just as much heat as usual, but uses only half the energy.**

COAL-ORE—THE HEART OF THE COAL

**It is nothing more nor less than the scientific adaptation of the natural elements of heat storing as discovered by the eminent professor who conducted the experiments. The application of coal-ore has demonstrated infallibly that coal can be made to last twice as long and yet still give out the same heat. A single shilling packet will be ample to treat a Ton of Coal.**

*James E. Noble, Toronto, Ont.*

### Circuit Incomplete by a Foot

It was the custom of the repairmen in the car barn of a street railway to set various traps to shock any new comer. The drinking water was kept in a bucket on a small shelf. A carefully concealed live wire had been run down the back of the post with a free end of sufficient length to be brought around the post and hooked on to the handle of the bucket. One day a new man started to work, and the water-bucket trap was promptly set for him. Water was sprinkled on the floor around the drinking place to make sure that the ground connection would be good. After the new comer had taken several drinks without result (the connections being examined carefully after each drink and pronounced O. K.) and the rest had gone thirsty all the morning, someone inquired as to his "open-circuited condition." The explanation was quite a surprise to everyone, as he stated that he had helped to shock new men in his time and was perfectly well aware that the water bucket was loaded. He explained that the reason he was not affected was, that he was so unfortunate as to have a cork foot in place of one he had lost, and that it was only necessary for him to raise the good foot from the ground when getting a dipper of water. The limp was on the new comer, but the laugh was on the gang.—*J. E. Terman, Hartford, Conn.*

# Factors Affecting Commutation

By Arthur H. Brame

*SYNOPSIS—The influence upon commutation of armature reaction, induction in the commutated coils, local currents in the short-circuited coils, and the proper selection of brushes.*

In the study of commutation it is necessary to consider separately the influence of the distortion of the main magnetic field by the field produced by the armature current, the induction in the commutated coils by the sudden stopping and starting of the currents in the opposite direction, the local currents flowing in them while they are short-circuited by the brushes, and the important part played by the brushes.

Consider first the armature carrying a current supplied from some external source, as in a motor, while the field magnets are left unexcited. Conductors on the same side of the neutral plane carry currents in the same direction, while the conductors on one side carry currents in the opposite direction from those on the other side. The armature as a whole is, therefore, producing a cross magnetization, or a magnetic field across that which is established by the field magnet (see Fig. 1). Since two magnetic fields cannot exist in the same place at the same time, the outcome is a field across the armature which is the resultant of the armature and the field-magnet fields. The armature field at both top and bottom strengthens at one side and weakens at the other the field due to the magnets, and this results in a distortion. When the machine is running fully loaded the coils do not reverse in electromotive force at points directly between the polepieces, but at points further around in the direction of rotation in the case of generators and backward in the case of motors, due to this distortion of the field by the armature currents (see Fig. 2). Therefore, the brushes must be given forward or backward lead, according to whether the machine is a generator or motor; otherwise there will be sparking.

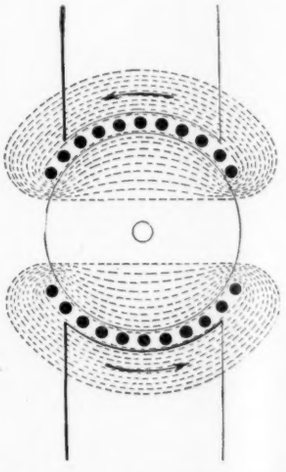


Fig. 1. Illustrating Magnetic Field Produced by Armature

Suppose the armature to be divided into 60 coils connected to a 60-bar commutator. The brushes will short-circuit at least one of these coils, and in some cases two, as they pass from one side to the other. The short-circuit on any coil lasts but a brief time, for if the armature be running at, say 10 revolutions per second, then one coil, forming only $^1/_{60}$ of the whole, will be short-circuited for $^1/_{600}$ of a second twice in each revolution.

Up to the moment of its being short-circuited by the brush, the coil (in a two-brush machine) has been carrying half the total current flowing in the external circuit, and in $^1/_{600}$ of a second this current has to be stopped, the electromotive force in the short-circuited coil reversed, and a current equal to half the external current, but in the reverse direction, started in it. If this be done before the short-circuit is broken the coil will break away from the brush without any sparking, but not otherwise. The only way to accomplish this is to give the brushes a further angle of lead, so that the coil, when on the point of being short-circuited by the brush, is cutting through the field in the reverse direction, so that this particular coil is developing an electromotive force contrary in direction to that which is urging the current through it. The reverse electromotive force on short-circuit rapidly stops the current flowing against it and starts another in the opposite direction. If the current in the short-circuited coil has not reversed on the short-circuit being broken, the current in it will be opposing the currents in the other coils on the side to which it has now been connected, and both will tend to arc across from the receding commutator bar to the brush, as indicated in Fig. 3.

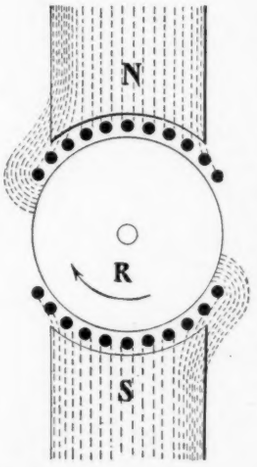



Fig. 2. Showing Field Distortion Due to Armature Reaction

It is evident that if the field magnet be magnetized to a high degree the pole tips will be highly saturated and the distorting effect of the armature current will be considerably less, owing to the high reluctance introduced into the circuit; hence the necessity for adjusting the position of the brushes for changes in the load will be decidedly less. In most modern dynamos this is done to a great extent, and in many machines there is no sparking at the brushes within ordinary variations of load, even on large overloads, though the brushes be fixed in position; this is especially true where carbon brushes are employed and the ampere-turns per commutator bar are small.

The current developed in the armature of a generator has to be collected by brushes pressing on the commutator segments. These are made either of copper or carbon, the brush-holders being designed to suit. Arrangements must be made for feeding the brushes forward as they wear, and to allow any brush to be raised and held off while the machine is running. Carbon brushes offer more resistance than copper, not only in the specific resistance of the substance, but also, and more particularly, in the contact resistance. This extra resistance, although it makes a great difference in the resistance of the circuit formed by the coil which is short-circuited by the brush, does not appreciably affect the resistance of the whole circuit, and it has a very beneficial effect on the commutating properties of the machine. Consider Fig. 4. The current is here flowing out by the carbon brush, and the coil *B*, which is becoming short-circuited by the brush, has a relatively high resistance put into its circuit, soon reducing its current to zero. The current from coil *A*

now divides at the brush, the larger portion going directly through the brush and a small portion passing through coil $B$ to the brush, for the brush and coil $B$ are in parallel. As the coil moves further around, more of the brush comes into contact with segment 3 and less with segment 2, until finally it is only just in contact with segment 2 (Fig. 5).

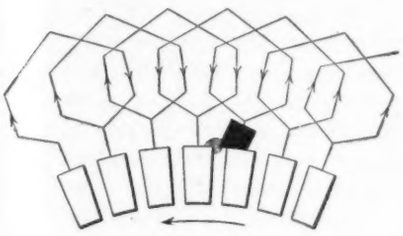


FIG. 3

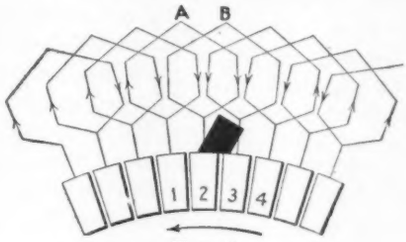



FIG. 4

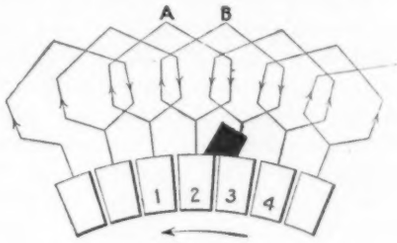



FIG. 5

ILLUSTRATING DIRECTIONS OF ARMATURE CURRENTS

As this proceeds the resistance from 2 to 3 across the brush is steadily increasing and, consequently, a larger and larger part of the current in $A$ passes through $B$ to the brush, until finally, as the brush breaks away from 2, there is little or no current flowing in that segment and, therefore, there is no sparking at the break. This enables the machine to be run with fixed brushes under large variations in the load, often from zero to full load; and the substitution of carbon for copper brushes has often prevented sparking in machines that before gave trouble in this respect.

There is one disadvantage, however, in using carbon brushes—one cannot allow as large a current density in the brush contact, otherwise they would get exceedingly hot. The maximum allowable current density found in practice is 70 amp. per sq.in. against 250 amp. with copper brushes. Since it takes a certain length of time to reverse the current, the brushes must be of sufficient thickness to short-circuit the coils for that length of time; on the other hand, they must not be so wide as to short-circuit a number of coils at the time, as this again would increase the tendency to sparking on account of increased self-induction.

Since the direction of a current causing a certain motion is opposite to the direction of the current caused by that motion, it follows that in a generator the current induced in the short-circuited coil has the opposite direction with relation to the current flowing in the armature from that induced in the short-circuited coil of a motor in the same position, when rotating in the same direction. That is, if in a generator the brushes are shifted so that the current induced in the short-circuited coil has the same direction as that flowing in the half of the armature it is about to join, in a motor revolving in the same direction and having its brushes set in exactly the same position, the current in the commuted coil (which absolutely has the same direction as in the case of the generator) would, relatively, have a direction opposite to that flowing in the half of the armature to which it is transferred by the act of commutation. While the brushes, in order to attain sparkless commutation, must be shifted with the direction of rotation, or must be given lead in a generator; in a motor they have to be shifted backward, or given lag.

In a generator the effect of commutation is a tendency to increase the aggregate magnetomotive force and, therefore, to strengthen the field; in a motor, however, the effect of commutation is to decrease the magnetomotive force and to weaken the field. Iron is very sensitive to slight increases of magnetomotive force, while it is comparatively insensible to a considerable decrease of magnetomotive force. In generators, therefore, the danger of sparking due to improper setting of the brushes is much greater than in motors.

Curve 1, Fig. 6, shows the value of the resistance of a unit section of brush contact plotted against current density in that contact; the resistance decreases as the current density increases, and for higher values than 35 amp. per sq.in. it varies almost inversely as the current density, and the voltage drop across the contact becomes practically constant, as shown in Curve 2. Such curves

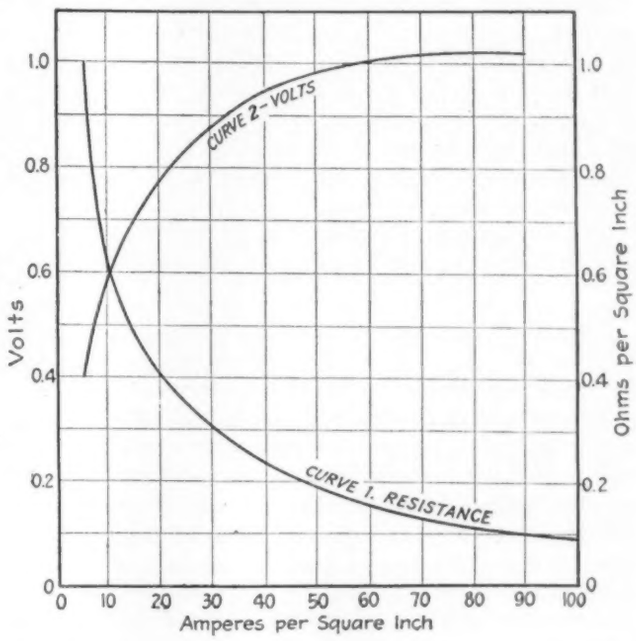



FIG. 6. CURRENT DENSITY, RESISTANCE, AND VOLTAGE DROP OF BRUSHES

of brush resistance are obtained by testing the brushes on a revolving collector ring and allowing sufficient time to elapse between readings to let the conditions become stationary. The resistance from ring to brush is generally greater than that from brush to ring by an amount which varies with the material of the brush.

It would seem that, by neglecting the effect of the variation of contact resistance with current density, the results obtained would be of little practical importance. It is found, however, that the variation in resistance is largely a temperature effect and that at constant temperature the contact resistance does not vary through such extreme

limits; also that, due to the thermal conductivity of carbon, the temperature difference between two points on a brush contact is not very great.

Suppose that, having reached the value of 10 amp. per sq.in., and the resistance having become stationary at 0.06 ohm per sq.in. (see Fig. 6), the current density were suddenly increased to 40 amp. per sq.in. The resistance in ohms per square inch would not fall suddenly to 0.023, but would have a value of about 0.06, and this would gradually decrease until, after about 20 min., the resistance would have reached 0.023—the value which it ought to have according to Curve 1, Fig. 6. This explains why a machine will stand considerable overload for a short time without sparking, whereas if the overload be maintained it will begin to spark as the brush temperature increases and the contact resistance decreases.

Sparking is cumulative in its effect because slight sparking raises the temperature of the brush contact, which reduces the contact resistance and causes the contact to become worse.

The brush contact resistance is found to decrease as the brush pressure increases and as the rubbing velocity decreases, but these effects can be neglected in any study of commutation, since the change due to rubbing velocity is small, while the brush pressure is fixed by the service and is made as small as possible. The brush pressure is seldom less than 1.5 lb. per sq.in. of contact surface, because at lower pressures the brushes are liable to chatter, while if the pressure be too great the brushes will cut the commutator if they are hard or will wear down and smear it if they are soft. A brush pressure of 2 lb. per sq.in. is seldom exceeded except for street-car motors, in which the vibration of the machine itself is excessive, and pressures as high as 5 lb. per sq.in. have to be used to prevent undue chattering.

The average energy expended at the brush contact must also be limited, as may be seen from the following table:*

| Kinds of Brush | Current Density | Volts across One Contact |
|---|---|---|
| Very soft carbon..... | 50-70 amp. per sq.in. | 0.6-0.4 |
| Soft carbon ..... | 40-65 amp. per sq.in. | 0.7-0.55 |
| Fairly hard carbon..... | 30-45 amp. per sq.in. | 1.1-0.9 |
| Very hard carbon..... | 25-40 amp. per sq.in. | 1.5-1.2 |

The product of amperes per square inch and volts drop across one contact has an average value of 35 watts per sq.in. It must be understood that these figures are for machines which operate without sparking and without shifting of the brushes from no load to 25 per cent. overload by using the proper grade of brush.

From the preceding, then, it is evident that sparkless commutation will be promoted: First, by dividing up the armature into many sections so as to do the reversing of the current in detail; secondly, by making the field magnets relatively powerful, thereby securing between the pole tips a fringe of field of sufficient strength to reverse the currents in the short-circuited coils; thirdly, by so shaping the pole surfaces as to give a fringe of magnetic field of suitable extent; and fourthly, by choosing brushes of proper thickness and keeping their contact surfaces well trimmed.

**The Velocity of Steam in Pipes** commonly allowed for medium and high pressure is 6000 to 8000 ft. per min., but the tendency of the present is toward much higher velocities (even to double the figures given), especially where considerable initial superheat is given the steam.

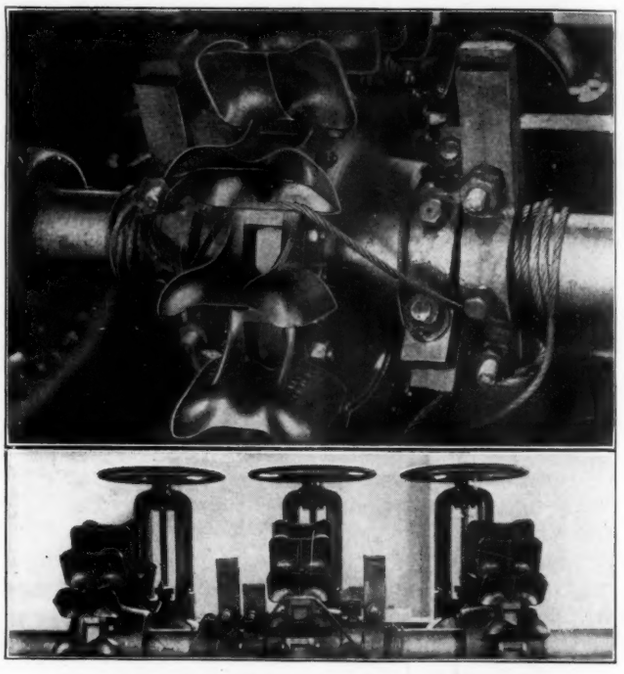
*Arnold, "Die Gleichstrom-machine," Vol. 1, p. 351.

## Repair to Waterwheel

By Walter Swaren

From far away Java comes an interesting example of a temporary repair. A waterwheel was shipped from San Francisco into the interior of Java to supply power for a tea plantation. It was necessary to sectionalize this wheel, and provision was made in the usual manner for a light press fit for attaching the hub to the shaft. The equipment for making the necessary press fit being rather difficult to obtain in the interior of Java, some refitting by hand was done. As a result, the fit of the middle spider (there being three spiders on the waterwheel shaft) was too light. After three years' operation it became loosened and worked endways on the shaft until it passed the key, thus rotating freely.

It was necessary that repairs be made quickly, as the accident occurred during the height of the season and



How the Wheel Was Made Fast

not more than two hours could be spared for the shutdown. It was obviously impossible, with the crude tools at hand, to arrange a new keyway or to put in setscrews; therefore, wire cable was drawn across the spider and wrapped tightly about the shaft by means of rough-forged clamps, as shown in the illustrations. It is interesting to note that but little more than two hours was required for making these repairs. The cure proved to be temporary, as in about a week the spider had again worked loose; then it was lashed in place in less than half an hour, which procedure had to be followed several times before the end of the season.

When the season was over, permanent repairs were effected by providing two clamps, one on either side of the wheel, with a notch in each which fitted about the boss on the hubs. These clamps carried bosses which in turn fitted into keyways sunk in the shaft, the whole repair being further held in place by setscrews. This left the spider held by two split-claw clutches.

All of the work was done by native Javanese laborers, under the direction of an engineer trained in the Netherlands.

# Air Testing in the Refrigeration Plant

By A. G. Solomon

*SYNOPSIS—The writer considers some of the dangers met in testing the refrigeration system with air. These dangers are not altogether absent when testing a new system. A special air pump should be provided always, so that the ammonia machine need not be used as an air compressor. Gage-glasses are not needed on the discharge gas receiver or on oil traps.*

Using an ammonia compressor for pumping an air test on a plant is something that should be given considerable attention. It is customary to test the high-pressure side of a plant with 300-lb. air pressure and the evaporating coils and other low-pressure piping with from 100 to 150 lb. Many engineers seem to belittle the danger of using the ammonia machine as an air compressor.

### Testing Newly Installed System

First, consider the risks in testing a new plant free from oil and ammonia. The machine is new and has been turned over by hand to ascertain that the clearance is right. Then it is turned over with steam, or with the motor if it happens to be motor-driven. With the steam drive the speed can be as slow as desired, but with the motor drive full speed is quickly reached. During this time the compressor does not draw anything from the evaporating side, as an opening is left so that the air is simply pulled in and forced out. Usually, much oil is put into the compressor to lubricate the valves and piston. Some of this lodges in small pockets in the valve cages and the globe valves in the pipes. After everything is ready the machine is turned into an air compressor and the test is begun. A full stream of water is turned through the water jackets, and often a hose is fastened to the discharge line and water allowed to flow over it to remove some of the heat of compression.

The machine should be stopped and allowed to cool after a discharge temperature of not over 250 deg. F. is reached. A thermometer should be inserted in the discharge line at this time, even if it is not left there for future use. The writer believes it would be a good thing to insist on discharge-temperature readings being taken during the test. The erecting engineer should be instructed as to what is a safe temperature and should keep within that limit. The oil for lubrication of the new compressor should be furnished by the builders, to avoid the danger of using an inferior lubricant or one with a too low flash temperature. This will mean that the thermometers and the oil will be a part of the erecting engineer's equipment. The lubricant used in many refrigerating plants is good as far as the low-temperature test goes, but when it comes to the question of gasifying under high pressure and temperature, that is another story. The danger of gas ignition and the resultant internal explosion is not any greater in the old system than in the new. The result of such explosion may be more serious in the former, owing to the possibility of ammonia being liberated.

### Scale May Start Explosion

In one way, the writer thinks, a new system is more liable to explosion than an old one. The cylinder surface and the moving valves and piston are not worn to a smooth finish, and the friction is therefore greater. Minute irregularities in these surfaces may easily create friction which may cause a spark that will ignite the gas given up by the oil used for lubrication. In the old compressor this danger is not present.

Another producer of sparks may be the particles of scale in the pipes. However well the piping is cleaned, there is some scale which becomes loosened and may find its way into the cylinder. A small piece of hard scale, getting between the piston and cylinder wall, may cause a spark. Also small particles of scale and grit are sent through the compressor valves and the pipe work at high speed. These may cause sparks.

### Soapy Water as Lubricant Prevents Explosions

There is one positive preventive for such explosions in testing a new plant. Do not use oil for lubrication. Use soap and water or some other material which will not give up a gas when subjected to heat. The amount of moisture thus introduced into the system will do no harm, as nearly all of it will be caught by the oil separator in the discharge line.

The proper way, and a way the writer believes should be insisted on, is the use of a special air pump for testing both new and old systems. Such an apparatus can be made to deliver air at a low temperature, and thus do away with the danger of explosion.

Where it is necessary to use a motor-driven ammonia compressor for pumping the air test, it should be stopped often and allowed to cool. This is annoying and takes a little more time, but it is safe. An hour or two more or less will not make any difference to the plant, whereas the bursting of a cylinder, receiver, valve or pipe work may delay the starting of the plant a week or more.

### Glass Gages Not Needed

The proper way to handle the gage-cocks on ammonia gage-glasses needs some little discussion. There are two different ideas as to what is the best position for the cocks to be in—whether they should be left open all the time, or closed and only opened to see how much liquid is in the receiver.

The practice of placing the gage-glasses on the discharge-gas receiver or on oil traps should be discouraged. They are not necessary and are in most cases useless for the purpose intended. On the discharge side of a compression system the gas receiver or oil trap will be cold up to the level of the oil, and by simply placing the hand on it the amount of oil contained is readily ascertained. Glass gages usually become dirty on the inner surface and the oil level cannot be plainly seen.

So this leaves but two places where glasses are needed. The first is on the liquid-ammonia receiver. To successfully operate the plant the liquid level in the receiver must be known at all times. A glass gage is the only positive indicator. These glasses should be protected with a fine-mesh screen to prevent pieces from flying when the glass breaks. They should also be protected in some way from the danger of being hit by something dropping on them or by material being carried past the receiver. The writer knows of one case where the wheel from a valve directly above the receiver came loose and in falling it not only broke the glass, but also one of the cocks was broken off. Ladders and lengths of pipe are often carried around in the engine room, and they may come in contact with the glass. But besides such accidents, glasses often break in a seemingly mysterious manner. In one plant where a glass had been broken by being hit with something and a lot of ammonia lost before the cocks were closed, the chief engineer gave orders to keep the cocks shut except when the operator wished to see the liquid level. Several glasses broke during the following few weeks. This is easily explained. When the cocks were opened and closed, the liquid ammonia at the temperature of the condenser was bottled up. The heat of the engine room caused this liquid to expand and the pressure burst the glass. After a little study this was overcome by leaving the upper gage-cock open enough to keep the pressure from becoming high. Another scheme was tried with success in a plant where glasses had burst several times. If the cocks were left open it invariably happened that something hit the glass; when they were kept closed the pressure burst the glass. Finally, globe valves were placed between the gage-cocks and the receiver, and the core of the cocks was filed so that there was a small opening even when they were closed. The filing had the same effect as a leaky cock. Then the cocks were left closed and the two valves left open. If the glass broke, the amount of ammonia escaping was so small that a man could get to the valves to shut them.

There are on the market several styles of safety gage-cocks that are provided with ball checks and are supposed to shut the ammonia off in case the glass breaks. These can be depended on to a certain extent, but are like most automatic apparatus in that they are liable to fail when needed.

### Gage on Brine Cooler

The other place where glass gages are used is on shell-type brine coolers where it is necessary to know the liquid level. These cocks are always left open and the glasses do not give much trouble by breaking. The pressure is seldom over 20 lb., and a man can get to and shut the cocks without much danger. But they should be provided with chains or chords so placed on pulleys that they can be closed from a point at least twenty feet away from the glass.

## Electrically Operated Stop Valve

A large railroad company was handicapped by not being able to quickly stop the engine which operated the coal and ash conveyor, because this engine was located in a remote and inaccessible place. When something went wrong with one of the conveyor buckets, such as a section of the conveyor chain jumping the track, which, while not frequent, did occasionally happen, considerable damage was caused, because the engine could not be stopped quickly. Other accidents are likely to happen, such as workmen getting caught in the machinery. In coal breakers accidents caused by men being caught in the machinery are frequent. In most mines it is necessary for someone to ring a bell in order to have the engineer stop the engine.

With the electrically operated valve herein described, anyone can quickly stop an engine by pushing a hand-

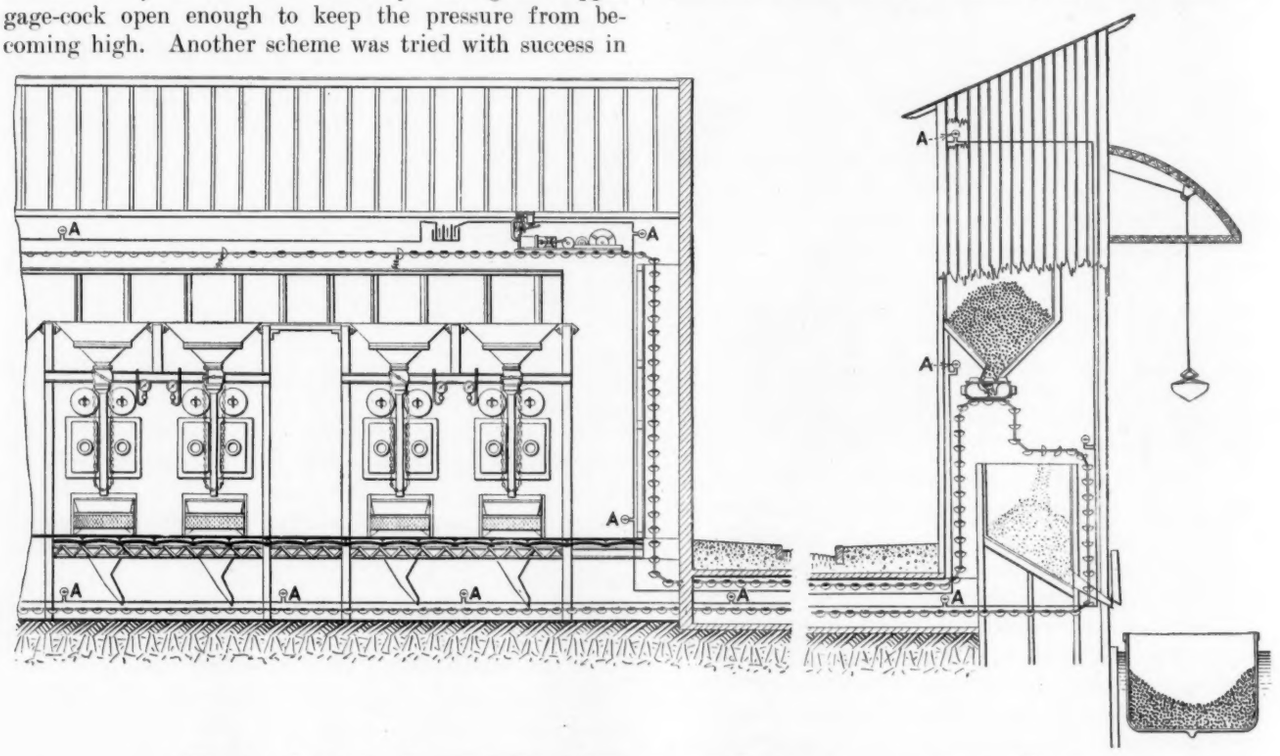



Fig. 1. Conveyor System, Push Buttons and Electrically Operated Valve

push switch, any number of which may be located at intervals along the length of the conveyor path, as at *A*, Fig. 1. This device does not remove the cause of accident, but it does offer a means for preventing accidents such as mentioned from resulting seriously, as the conveyor can be brought to a stop within 6 in. of travel after a switch has been pushed.

### Description of Valve

Fig. 2 shows a side and end view of an electrically operated valve of the inverted-lever type. It is fitted with

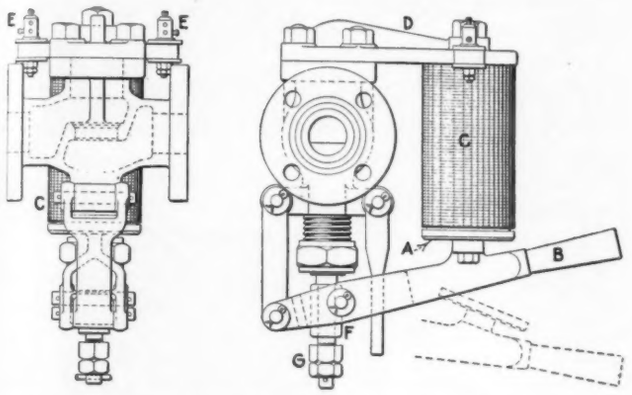



Fig. 2. Front and Side View of the Electrically Operated Valve

a hand lever *B* that carries an armature *A* by means of which the valve is held open by the ironclad closed-circuit magnet *C*, supported from the valve cover *D*. This carries heavy binding posts *E* on either side, which take the magnet and line terminals. The hand lever *B* is suspended from the valve body by a link and carries a trunnion *F* by means of which the valve spindle is held in its highest, or open, position. When the current is interrupted on the coil, a hand-push switch being operated, the hand lever drops to the position shown by the dotted lines, and as there is a clearance between the bottom of the trunion tee and the nut and check nuts *G* on the spindle, the weight of the lever strikes the spindle an impact blow, so as to insure closing against the stuffing-box friction. The pressure enters the valve body on the top seat side and acting on the valve disk, keeps the valve closed, aided by the weight of the disk spindle, and the hand lever resting thereon.

A guide is placed on the side of the body opposite the link, which fits into the crotch of the hand lever and relieves the spindle of any strain which might be caused by pulling the lever sideways. The two lugs on the body—one for the link and the other for the guide—are identical and permit the hand lever to be turned to face the opposite way.

The cover can also be fitted on so that the magnet will face in an opposite direction, which permits the valve to be made either right- or left-hand to avoid interference with obstructions in restricted places.

The magnet can be wound for a 10-cell storage battery or 110-volt direct current. For 220 volts an outside resistance unit is used in series with the 110-volt winding. The current consumption is approximately $\frac{1}{4}$ ampere for the storage battery and $\frac{1}{10}$ ampere for either 110 or 220 volts, direct-current.

After the valve has been closed by the opening of the circuit on the coil, it is again opened by lifting the hand lever to its highest position, where it will be held by the attraction of the magnet, the circuit having been re-established immediately after having been opened, because the hand-push switches are of the self-resetting type.

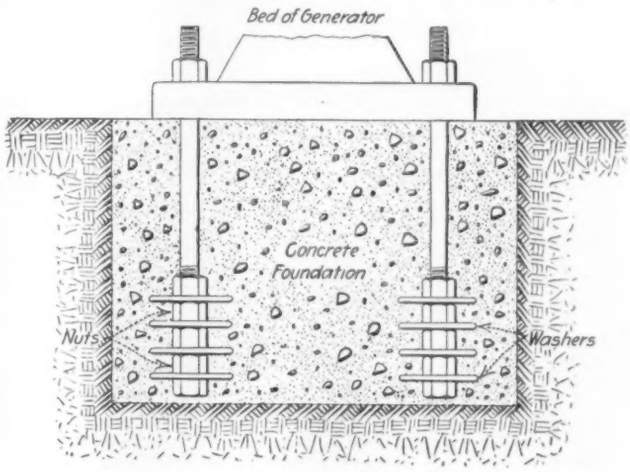
This valve must be used in conjunction with the existing stop or throttle valve on the engine, and should be placed between it and the engine cylinder. The valve is made in sizes from 1 to 2 in., inclusive. It is manufactured by the Schütte & Koerting Co., Thompson and 12th St., Philadelphia, Penn.

## Anchoring Foundation Bolts in Concrete

By Terrell Croft

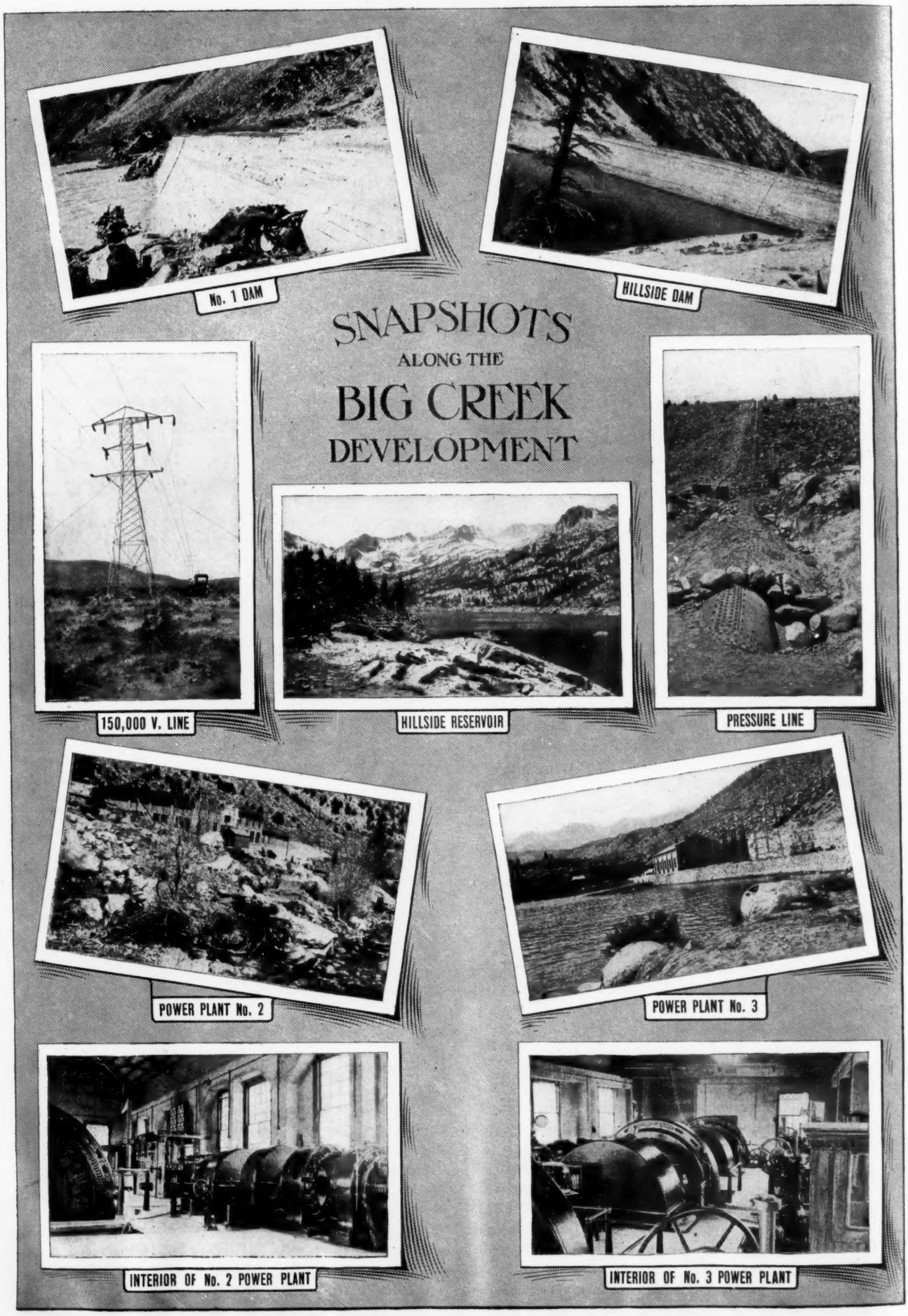
The effectiveness of the adhesion between an iron rod and the concrete in which the rod is embedded does not appear to be generally appreciated by many men who install concrete foundations for machinery. For example, the arrangement shown was used in a certain instance to provide an anchor for the foundation bolts of a machine. The series of nuts and washers on the lower ends of the bolts was entirely unnecessary, as will be demonstrated.

The maximum adhesion between a round iron rod and concrete amounts to between 250 and 400 lb. per sq.in. of contact area. A safe value for this adhesion may be taken as 75 lb. per sq.in. These values have been verified many times by actual tests. Working from these data, it can be shown that if a round iron rod is embedded in concrete to a depth equal to 30 times its diameter the rod will break before it pulls from the cement if force is applied to effect its withdrawal. Therefore, if a 1-in. diameter foundation




Unnecessary Nuts and Washers on Anchor Bolts

bolt with its surface perfectly smooth be set in concrete for a depth of 30 in., the rod will break before it can be pulled loose from the concrete. Roughening the rod by threading it or by chipping or by cutting fins in it has very little effect, one way or the other. However, as a matter of precaution it is always well to use for a foundation bolt a rod threaded and having a nut on the lower end. On this nut a cast-iron building washer or a square piece of wrought-iron plate can rest, which will insure against withdrawal if the bolt is not set 30 or more diameters in the concrete.


SNAPSHOTS
ALONG THE
BIG CREEK
DEVELOPMENT
No. 1 DAM
HILLSIDE DAM
150,000 V. LINE
HILLSIDE RESERVOIR
PRESSURE LINE
POWER PLANT No. 2
POWER PLANT No. 3
INTERIOR OF No. 2 POWER PLANT
INTERIOR OF No. 3 POWER PLANT

# Air-Lift Efficiency

By E. M. Ivens

*SYNOPSIS—Probably no mechanical device is as little understood in detail, or is subjected to so much abuse on one hand and praise on the other, as the air lift. Many engineers maintain that the air lift is inefficient, and should never be employed when anything else is obtainable; others credit it with a higher efficiency than is actually attained. Somewhere between the extremes is the proper place for the system.*

Two descriptive theories of the air lift have been advanced—one by J. P. Frizell in 1880 and the other by Dr. Julius Pohlé in 1892. Each was granted a patent on a system of piping a well, and in each letters patent the theory is given.

Mr. Frizell says: "My present invention has for its object the elevation of water in a simple and convenient manner by the introduction thereunder of compressed air; and it consists in causing a column of water to ascend in a pipe or conductor by the injection therein, at or near its bottom, of compressed air, the weight of the air and water thus commingled being overcome by the weight of the external water which is thus utilized as a motive power to elevate the water." . . .

Dr. Pohlé says: "The object of the invention is to effect successfully and practically the elevation of the water to a much greater height than has heretofore been deemed economical with compressed air, and to avoid the results due to an ultimate commingling of the air and water, as well as to dispense with all valves, annular spaces and solid pistons. In accordance with my invention, the air is not directed into the water in the form of fine jets or bubbles, which would very readily commingle intimately with the water, but is delivered in mass, and the water and air ascend in well defined alternate layers through the eduction pipe."

Mr. Frizell claims a thorough aëration for his system, while Dr. Pohlé claims a piston-like layer formation of air and water for his. Fig. 1 is an illustration of the two principles.

Dr. Pohlé's idea was that the pistons or layers of air entirely filled the cross-section of the discharge pipe, but as shown in Fig. 1, in actual operation these air pistons only partially fill the cross-sectional area. Consequently, each ascending air piston cannot carry all the water before it; a certain amount (that contained between the air piston on the walls of the eduction pipe) is not raised and the air piston is said to "slip" by this water. This slippage loss is the most serious to be contended with in air-lift practice.

In a mathematical theory developed by Prof. Elmo G. Harris, it is shown that the air-slippage loss varies with the square root of the volume of the air bubble admitted to the water column, therefore it is advantageous to reduce the size of the bubbles by any means possible. This undoubtedly is nearly correct because it is only reasonable to suppose that the sum total of air-slippage losses will be considerably smaller in a rising column of air and water if a large number of finely divided bubbles are introduced than if a comparatively few large ones are employed. In other words, it is evident that, taken as a whole, the cross-sectional area of the pipe is more effectively occupied by the air in the Frizell aëration principle of operation than in the Pohlé piston-like layer principle. Experiment plainly indicates that this conclusion is correct.

## Application of the Air

One of the first considerations in designing an air lift for any set of conditions is the manner of introducing the air, or the method of piping the well. Any system

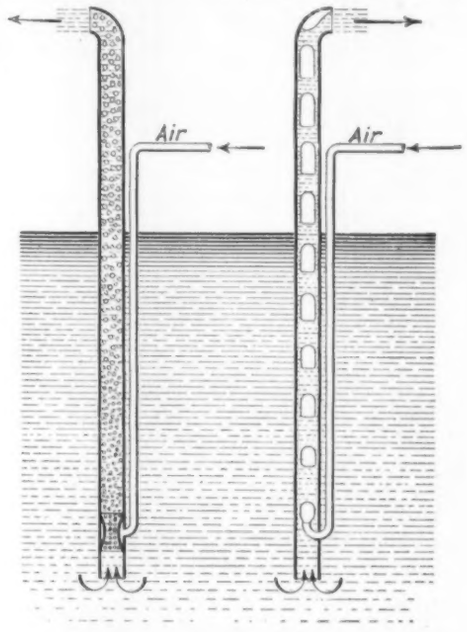



Fig. 1. Aëration Principles of Operation

that finely divides the air volume and provides a free passage for the mixed air and water will be found satisfactory. In Fig. 2 are shown a number of the systems of piping most frequently installed, the letters *A*, *B*, *C* and *D* referring to parts common to each system. Besides these there are several manufactured systems having specially designed head and foot pieces and for which broad claims of superior economy are made. In some of these dependence is put upon refined nozzles and deflector tubes for obtaining the efficiency claimed.

## Submergence

Air slippage is also affected by the amount of submergence, or the distance below the surface of the water that the air is admitted to the discharge pipe. To thoroughly appreciate the importance of this feature in air-lift design, consider briefly the characteristics of the bored well and the water-bearing stratum that it penetrates.

Water-bearing strata usually consist of sand or gravel. At some point, which may be more or less remote, these strata reach the earth's surface, where they receive their supply of water from rivers, springs or rainfall. The ideal arrangement is the water-bearing stratum located between two impervious strata, so that there is no escape of water

either upward or downward. No such perfect formation exists, but nearly impervious confining strata are found, so for the sake of simplicity of explanation we may assume that the water is held in the stratum in the same manner as in an underground pipe. This stratum we will assume to have a source of supply without an outlet.

Suppose now, that, as illustrated in Fig. 3, a well were drilled at $A$, piercing the upper strata and entering the water-bearing stratum. An outlet is now provided and the water, seeking its level, will rise up in the well until its surface at $B$ coincides with a horizontal line drawn from the surface $C$ of the source of supply. The distance from the ground surface to the water surface in the well is known as the *static head.*

If an air lift is installed in the well, as shown in Fig. 4, and operation begun with the static head $h$, there will be created a flow from the source of supply to the mouth of the well. Immediately the initial water level $XB$ drops with a head loss $XC$ due to the friction of the water in passing through the stratum and entering at the lower end of the well. Under the dynamic conditions, the head at the source cannot then maintain an equal head in the well, and the difference between the two is known as the *well head drop.* The *static head* plus the *well head drop* is known as the *pumping head* of the well.

Referring to Fig. 4, the air pressure introduced at $A$ (pounds per square inch) necessary to start operation of the well is equal to the distance $h_s$ in feet multiplied by 0.434, and the pressure necessary to keep the well operating after it has been started is equal to the difference in feet of $h_s$ and the well-head drop multiplied by 0.434; so that the well-head drop in feet may be ascertained by noting the starting and running pressures on the air gage and dividing the difference by 0.434.

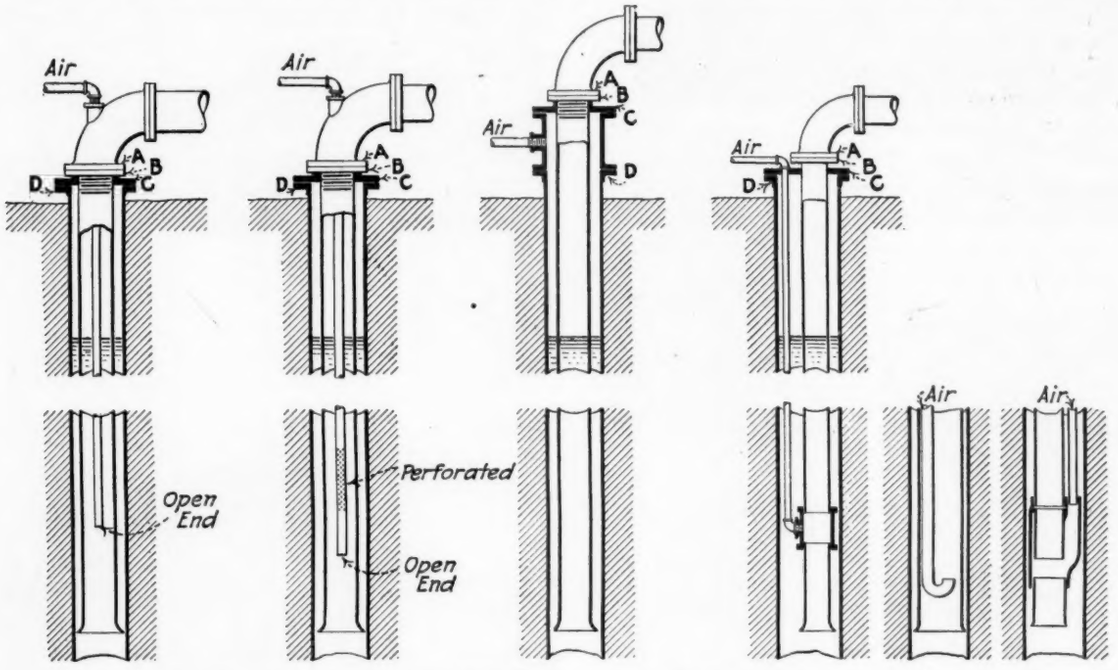



FIG. 2. PIPING SYSTEMS MOST COMMONLY EMPLOYED FOR AIR LIFTS

Besides the pressure reduction caused by actual falling of the head in the well, there is a slight pressure drop due to established column momentum. In other words, less energy is necessary to keep a column of water moving than is required to start the same column from a state of rest. This pressure difference is plainly equal to the velocity head, which is $\frac{v^2}{2g}$, multiplied by 0.434.

There is a certain amount of frictional resistance in the eduction pipe, and this increases the operating pres-

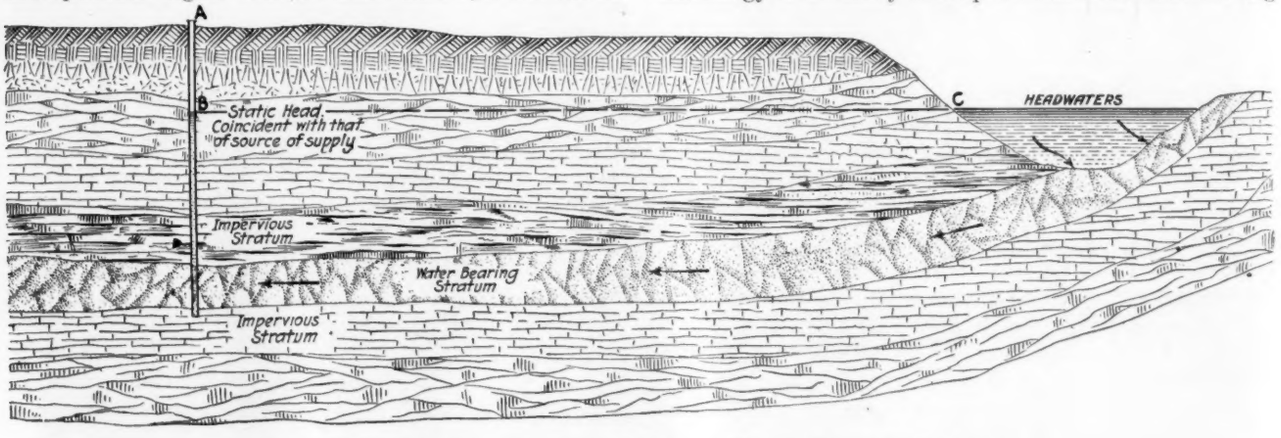



FIG. 3. STATIC HEAD OF WELL BORED TO WATER-BEARING STRATUM

sure over that stated. It is usual to assume that this pressure increase cancels the pressure decrease due to column momentum. For all practical purposes, then, it is sufficiently accurate to say that the submergence in feet is equal to the air pressure multiplied by 2.31 or conversely, of course assuming that the air-transmission losses have been accounted for.

The air pressure that the compressor must operate against is dependent upon the amount of submergence (plus air-transmission losses) of the air line. Experience has shown that as the submergence is increased the air-slippage losses decrease, which means that a lesser volume but increased pressure of air is needed; on the other hand, decreased submergence requires increased air volume but decreased pressure. Since these two factors (pressure and displaced volume) constitute work, it is important that the question of submergence be carefully considered.

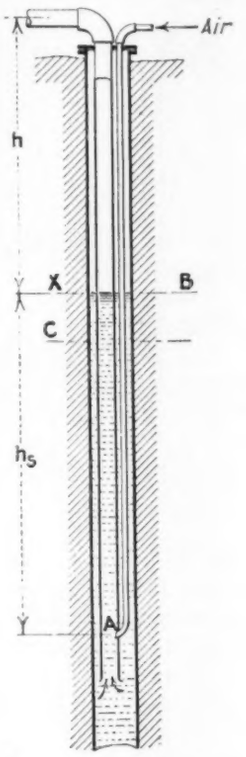



FIG. 4. STATIC HEAD AND WELL-HEAD DROP

There are no rules or laws that tell just what constitutes proper submergence; it is purely a matter to be determined by actual experiment in each case. A number of tests should be made with varying depths of submergence and the most advantageous depth selected. This is a very simple matter, indeed, and well worth the time expended. To show the effect of varying submergence on the efficiency of an air lift, there is reproduced in Fig. 5 a typical submergence curve. The curve was plotted from the results obtained from a test made on a well owned and operated by the City of Hattiesburg, Miss.* As will be noted, the efficiency falls off rapidly between 50 and 65 per cent. and between 75 and 95 per cent. submergence, but between 65 and 75 per cent. the difference in efficiency is only about 1 per cent. The most advantageous point of submergence is 70 per cent.

The proper percentage of submergence varies with the dynamic lift, decreasing as the lift increases. From numerous tests the writer has found the following to be about right, though, as stated, only a test can accurately determine the proper submergence in any particular case.

| Lift | Submergence | Lift | Submergence |
|---|---|---|---|
| 25 to 50 ft | 70 per cent. | 201 to 300 ft | 50 per cent. |
| 51 to 100 ft | 65 per cent. | 301 to 400 ft | 45 per cent. |
| 101 to 150 ft | 60 per cent. | 401 to 500 ft | 40 per cent. |
| 151 to 200 ft | 55 per cent. | | |

## THE EDUCTION PIPE

Another factor which affects to a large extent the efficiency of operation of an air lift is the size and design of the discharge or eduction pipe. The small area of the well and the standard pipe diameters prohibit nicety of construction, even if enough were known to prepare an accurate design, but a material gain in efficiency can be made by exercising a little care and judgment in the use of our limited facilities and knowledge.

It must be remembered that the discharge pipe transmits a mixture of a practically incompressible liquid and a very elastic gas, and both are under a varying pressure. At the lower end of the pipe the pressure is equivalent to the depth of the submergence, and as the mixture rises the pressure reduces in proportion. The reducing pressure causes the air to expand and occupy an increasing area of the pipe. This causes the velocity of travel of the column to increase as the top is approached.

The demands of high efficiency for transmitting a mixture of air and water are conflicting. Air-slippage losses increase as the velocity of flow is diminished, and water frictional losses increase as the velocity squared is increased. In figuring the pipe diameter it is necessary to ascertain a velocity of flow where the sum of these two losses is least. Here, again, is the need of experience and experiment (for there is no other guide) and, unfortunately, we have neither. Then, too, we have the varying column velocity mentioned to contend with.

About all that can be said is that at no point in the discharge pipe should the column velocity be as low as

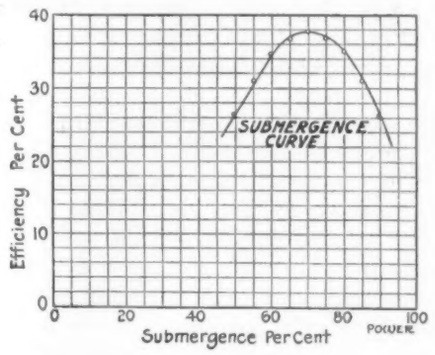



FIG. 5. VARIATION IN EFFICIENCIES FOR DIFFERENT PERCENTAGES OF SUBMERGENCE

that with which an air bubble will ascend in still water, and on the other hand at no point should it be so high that the water-friction losses overcome any gain obtained by small air-slippage losses. Also, the column velocity should increase as the air volume expands.

The writer has obtained good results with an initial velocity of 8 to 11 ft. per sec. and a discharge velocity of 22 to 24 ft. per sec. In high lifts and consequently long discharge lines, to prevent the velocity becoming excessive a gradually increasing pipe should be used. Initial and final velocities in each section of pipe of approximately 11 ft. and 22 ft. respectively will be found very satisfactory.

## AIR PIPE

In a large percentage of air lifts the pipes for transmitting the air are too small. For obvious reasons these should be as large as possible, within reason. A velocity of travel of 30 ft. per sec. is considered good practice.

## EFFICIENCY

If due consideration is given to the prevention of air-slippage losses and other economy essentials observed, the actual pumping efficiency of the air lift compares favorably with that of any other system of deep-well pumping.

*See page 116, "Pumping by Compressed Air," by E. M. Ivens.

When reliability and convenience are considered the air lift stands alone, and where conditions are suited it should be installed, by all means.

The very simplicity and reliability of the air lift have, however, gotten it into trouble a number of times. It has been installed where sufficient submergence was not available, and, consequently, the efficiency proved low. The one and only drawback to the air lift is the high percentage of submergence necessary to efficient operation.

The writer has obtained pumping efficiencies varying from 50 per cent. on lifts of 50 to 75 ft. to 18 per cent. on lifts of 900 to 1000 ft. These efficiencies were obtained, of course, after experimenting to ascertain the proper submergence.

## Steam Generation in a Wood-Distilling Plant

By Lawrence Eddy

A battery of steam boilers burning six different substances—gas, liquids and solids—in the same fireboxes is rather unusual. Yet such are the conditions in the plant herein described, and which are quite typical of the wood distilleries in the East.

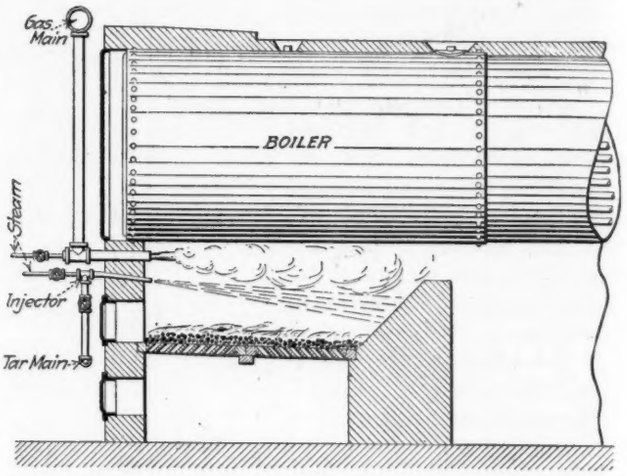
The steam for this plant is generated in three return-tubular boilers rated at 150 hp. each. They are set over stationary grates whose dimensions are approximately 6x6 ft. Air is supplied by a strong natural draft.

In the process of distilling hard woods several unmarketable products are obtained which are also combustible. They are burned, in this case under the boilers, as much for the sake of being rid of them as for the heat energy which they possess. When the wood is heated in the ovens about 20 per cent. of it, by weight, is converted into a noncondensible gas. In this plant, which burns 60 cords a day, this will amount to about 600,000 cu.ft. every 24 hrs. After washing, the gas is led in cast-iron mains to the upper corner of each firebox, as shown in the sketch. It merely escapes from the end of the pipe and mixes with the furnace gases, burning with a pale-blue flame in the top of the firebox. Its combustion is supported by the excess air which passes up through the fuel bed on the grates. A steam jet placed in the pipes just before they enter the fireboxes assists the flow of gas and prevents the furnace gases from working back into the mains and causing an explosion when the wood gas is not running. As there is no gas tank in the line, the supply at the boilers is intermittent and must be burned just as it comes, without any regulating valves which might cause a back pressure on the ovens.

The second class of fuels is the wood oils. These distill over with the alchohol and acetic acid, in the processes of purifying the wood vinegar or "raw liquor." They separate from the alcohol and acid by gravity, are washed, and run off to the tar sump where they mix with or float on the tar. They still contain a considerable amount of water and acid.

The residual tars which remain after the alcohol and acid have been distilled off resemble in appearance the familiar gashouse tar and have a very acrid odor, due to acid which cannot be entirely separated from them. Between 1000 and 2000 gal. accumulates every day, and is run off while still hot to the tar sump, together with the oils previously mentioned. Brass piping (to resist the acids) carries the mixture to the fireboxes, into which it is injected with considerable force by a steam jet, as shown. No attempt is made to atomize the liquid, it being merely hurled in large globules against the bridge-wall, spattering back and burning on top of the fuel bed. If fed too fast it builds up into a large mass which has often nearly filled the firebox. It will also run down into the fuel if fed too fast, and make a hard clinker in the grates.

In connection with the plant there is a sawmill which delivers the sawdust and refuse from 7000 ft. of lumber




Connections at Furnace Burning Solid, Liquid and Gaseous Fuels Simultaneously

a day to the boiler room. It is dumped into a bin by a chain conveyor and shoveled by hand into the fireboxes. When too green and wet to burn readily the sawdust is sometimes mixed with coal before firing. It is the practice to fire the sawdust all into one firebox; this is, of course, wrong, for since it is a much inferior fuel to the coal and the grate areas are the same, it follows that the two boilers fired by coal are overloaded, while the one fired with sawdust does not carry its share of the load.

As the waste fuels do not furnish the necessary heat for all steam making, it is necessary to burn large quantities of fine pea anthracite coal on the grates. These fires must be raked off the grates periodically, and in kindling the new fire quantities of charcoal screenings are used. These screenings are a more or less waste product, and make excellent kindling. It is necessary to shut down the dampers when they are on the grates, to prevent them from blowing up the flue, they are so light.

The careful engineer will doubtless see much room for improvement in the arrangements mentioned, but owing to the extremely conservative spirit in the industry it is difficult to try out innovations; the coal bill is regarded as a necessary evil and, apparently, no further thought given to it.

## Simplex Emergency Jack

The Simplex emergency jack, recently placed upon the market, is a tool of usefulness and utility wherever there are loads to be lifted or pushed. It practically combines a crane and a jack. The accompanying illustration shows the jack acting as a crane in changing the location of a boiler, wherein pushing at an angle and lifting are necessary.

The standard is a heavy malleable-iron casting ribbed for stress in every direction. The circular bottom of

the frame rests with a machine fit upon two circular shoulders, which are a part of the large, well-proportioned base. In this way the base takes the load, and the steel pin acts to hold the frame in position. The rack bar and cap are heavy drop-forgings. The top of the cap is recessed for the chain, which is a part of the equipment. The double socket of crucible steel makes it possible to

SIMPLEX EMERGENCY JACK

handle a load with the jack at any angle. A heavy trunnion bearing supports the socket. The working angle of the jack is from 30 to 90 deg. to the horizontal. The trip at the back of the base either holds the frame in a rigid vertical position or releases it to pivot on the base. Five feet of chain and a 5-ft. steel lever bar comprise the equipment. The jack is manufactured by Templeton, Kenly & Co., Ltd., Chicago, Ill.

## A Home-Made Cooling Tower

BY A. D. WILLIAMS

An expense often overlooked in the operation of a gas engine is the cost of cooling water. This is particularly the case in city installations where the local water-supply is the only one available and meter rates must be paid. J. F. Kalb, chief engineer at the factory of the Willard Storage Battery Co., Cleveland, Ohio, was confronted with a problem of this kind several years ago. As the size of the power plant was increased by the addition of new engines the water bill increased until it was about $2300 per year, a part of the water being used in the factory, but the larger portion in the engine jackets. Mr. Kalb suggested that a cooling tower upon the roof of the engine room would enable him to use the water over and over again instead of wasting it to the sewer, and finally, he was authorized to build the cooling tower shown in Fig. 1, which was made entirely in the company's factory.

The base of the tower is a lead-lined sump or tank about 5x16 ft., supported on a rack upon the roof and deep

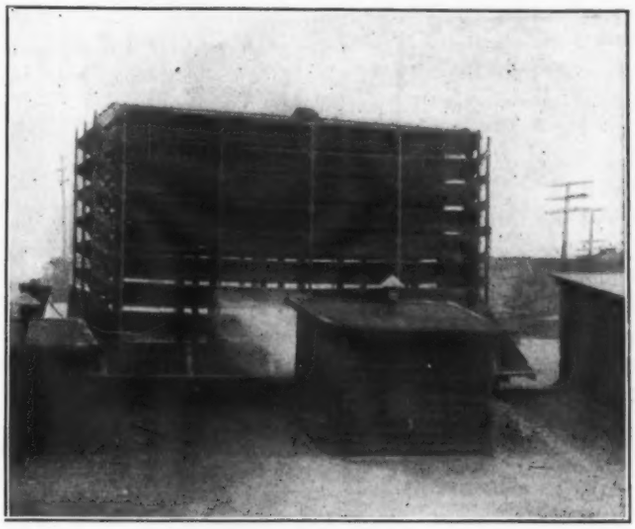


FIG. 1. GENERAL VIEW OF TOWER

enough to hold a foot of water. This tank is provided with an overflow to limit its water line and a ball-and-float valve to admit make-up water as required. The use of sheet lead avoided the necessity for making water-tight joints in the woodwork which might have been more troublesome. The bottom of the tank was built as a

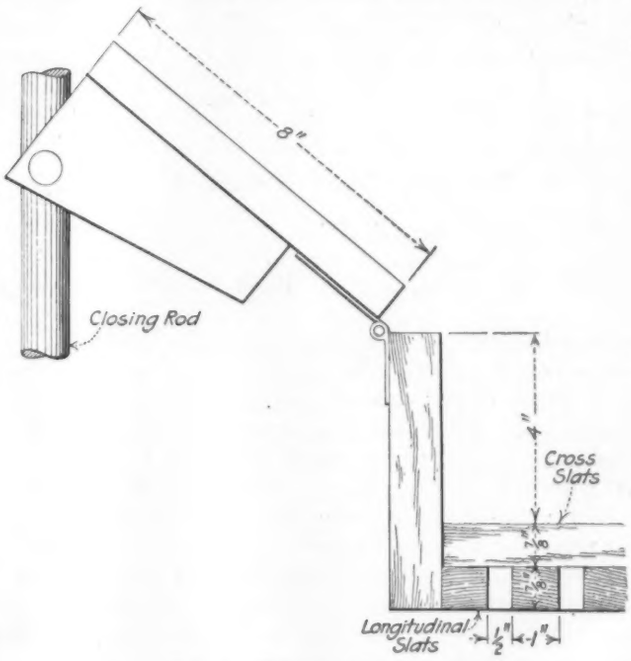



FIG. 2. DETAILS OF TOWER

platform, with heavy battens on its under side, and the sides rest on the platform and are supported by brackets. The joints in the lead lining are burnt, not soldered, and pipe connections are made to the lining by brass flanges soldered to it.

Above the sump there are nine trays about a foot apart, supported by posts that rest on the bottom of the tank,

the lowest tray being 8 in. above the sump. These trays are 4 in. deep and slightly smaller than the tank, their bottoms consisting of racks made up of 1-in. slats crossing at right angles and so arranged that the openings in one tray are not below the openings in the tray above. Water is delivered through a manifold and pipes to the top tray and to the fifth tray from the bottom, the latter arrangement being for use in cold weather. As originally planned, wind-shields were hinged to the top of each tray so that the windward side of the tower could be closed to prevent the spray being blown out on the roof. In practice, however, it was found that these shields became coated with ice and could not be closed in cold weather, except with difficulty. The construction of the trays is shown in Fig. 2.

The cost of this cooling tower, including erection, was slightly under $500, and the first year's operation showed a water bill of $300—a reduction of $2000 from that of the year before. This reduction in the bill caused the water department to test the meter used, after which the accuracy of the bill was not disputed.

## Supporting Horizontal Return-Tubular Boilers

By F. W. Dean

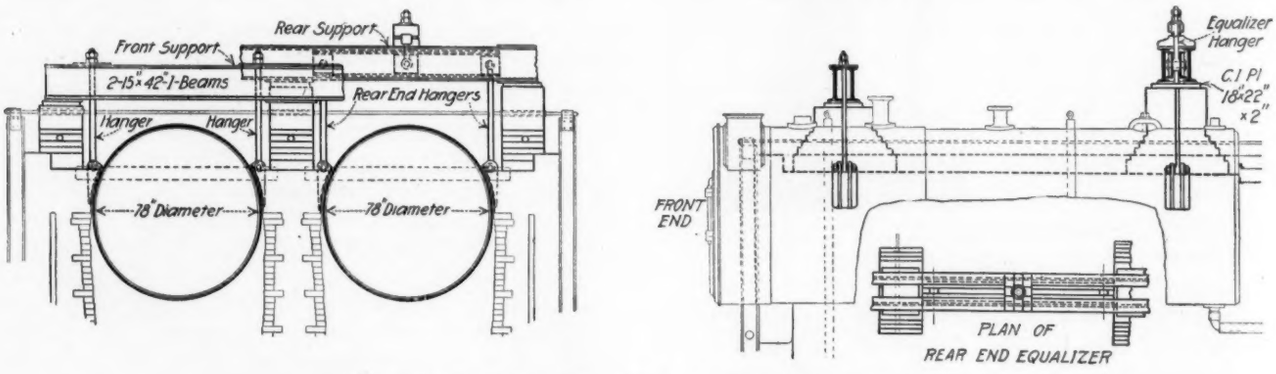
The manner of supporting horizontal return-tubular boilers is of considerable importance. Such boilers should be supported at no more than four points—on both sides near each end. If a boiler is of much length some builders support it at six points. Having an intuition that it is doubtful if the different supports will carry equal weights, they sometimes place springs under the middle ones, thus making the supports somewhat flexible without removing the uncertainty. This is only a makeshift, as even with the use of springs the inequality of supporting pressures is as great as ever.

It is a principle in mechanics that if a body rests on three points the pressure at each point can be determined, and will not change. A three-legged stool always rests properly on its legs and with unchanging pressure, even when it rests on an irregular floor; but a stool with more than three legs rarely presses equally on each, and if its feet were carefully fitted to bear equally on an ordinary floor, a little change in position would destroy the fitting. This illustrates that in supporting a horizontal return-tubular boiler the three-point principle should be applied. This, I believe, was first done by Orosco C. Woolson, and by him made public in a paper read before the American Society of Mechanical Engineers in 1898 and published in Power in November of the same year. If one end of the boiler is supported by two of the usual brackets, one on each side, or is suspended from above by two rods, one each side, and the other end is supported by two rods from above, one on each side, and connected to a hinged equalizing lever, the three-point principle is realized. When this is done the pressure on the brickwork and the strains in the supporting parts never change, even if the brickwork settles. If, instead of having an equalizing lever, the rear head were connected to an overhead beam by means of a hinged joint, the same principle would be applied. This may be a simple and good way to carry out the principle.

If it is doubted that a boiler can stand the strain of being supported at the ends, by treating it as a girder and knowing its weight when full of water, it will be found that the strain in the shell is next to nothing, and it will be seen that this method of support is safe for almost any horizontal boiler which is otherwise properly designed. In practice the case is not as bad as that just suggested, for the points of support are never at the extreme ends, and they can be so chosen that the boiler becomes a well proportioned continuous girder over the points of support, thus reducing the shell strains to a minimum.

Another feature of the usual method of supporting the type of boiler under consideration that merits criticism, is the design of the brackets. While I never knew of the brackets breaking or pulling away from the boilers, they should be designed with a row of rivets below the horizontal part that rests on the brickwork, thus reducing the stress on the bracket rivets.

The illustration shows how I have carried out the Woolson three-point principle since 1899. I first used it for 90-in. boilers for S. D. Warren & Co., but the illustration is that of some 78-in. boilers for Walter Baker & Co., Ltd., at their Montreal plant.




Rear Ends of Boilers Suspended from Equalizers

**The Holding Power of Tubes,** as shown by a series of tests, is given by J. M. Allen as follows: Tubes expanded but not flared or beaded, 5000 to 7500 lb. pull; tubes expanded and ends flared, 19,000 to 25,000 lb. pull.

**Pipe Corrosion**—In an effort to settle the important and mooted question as to which material better resists the action of corrosion, the National Tube Co. for years has made a practice of shipping with steel pipe wrought-iron couplings, so that the corrosion of each material could be judged by comparison under the same conditions of service. As a result they have concluded that there is no doubt as to the advantage of steel pipe and have abandoned the manufacture of charcoal and puddled iron for welded tubes.

# Editorials

## Weak Spots in Hydro-Electric Plant Design

Recent studies of water-power development for electric transmission disclose the need of broader operating knowledge in some instances, in order to realize the highest possible plant efficiency and the safest running conditions. Foresight in development cuts a greater figure in hydro-electric plants than almost anywhere else, in view of the costliness of changing such installations once they are completed. Both on the mechanical and the electrical sides improvements are desirable, as the following typical points illustrate.

Consider the problem of utilizing the available head. In this connection plant location is of decided importance, requiring thorough study by engineers of experience in order to avoid sacrificing a portion of the water drop which can be utilized easily without undue increase in investment. In one plant with a thirty-two-foot head, the available fall on the turbine runners might have been increased to forty feet had the station been located a couple of hundred yards down stream, and the output could have been increased accordingly, with still less service required of the auxiliary steam plant. The operating engineer in charge of the station pointed this out to a visitor familar with such work, and it was seen that the contention was true. The case was one where the company might have saved many thousands of dollars a year had its preliminary plans been shown to the operating staff for criticism. The adoption of the engineer's suggestions was in no sense obligatory, and there could have been no cause for dissatisfaction had the management decided, in the face of all the information before it, to proceed along the lines which it actually followed. Failure to realize the full possibilities of such a situation, however, is a misfortune, for day and night there is a loss of head below the tailrace in this station which might well have been turned into the wheels and made to earn revenue for the company.

Men who have to run plants of this kind realize the value of adequate hydraulic arrangement, including provision for getting at the rear bearings of turbine sets and ample sluice gates at the dam and forebay, so that the requirements of drainage can be met properly. Now and then only partial provision is made for emptying the forebay or for the removal of trash and leaves from the screens at the intakes. Ample lighting facilities here are as important as in the generator room itself. In one recently completed station a space of six feet wide has been set aside for reaching the rear bearings of the water-wheel units; and this, illuminated by a special circuit of tungsten lamps, means real comfort and resulting efficiency for the staff. It costs something in additional masonry or concrete to provide such a space, but in case of trouble, accessibility of such bearings is a valuable feature.

On the electrical side two points that deserve more attention may be emphasized. One is the practice of crowding too much switching and auxiliary apparatus into a limited space on a switchboard gallery, and the other is the need of better mechanical structures to support outgoing transmission and feeder lines. In one instance where the station design was studied in the light of operating experience, the potential transformers for various instruments were mounted on a frame above a concrete bus structure containing oil switches. The designer of the station probably never gave a thought to the danger of replacing fuses on these transformers in such a location, close to busses carrying high-tension energy and reached only by planking carried on pipe framing above the switch compartments. The fuses may be replaced with tongs, but nevertheless the position from which the operator must work is perilous, and had the designer consulted with men experienced in actually handling the type of plant in mind, it is probable that an entirely different location for the transformers would have been found.

## Engineers and Supply Houses

One of the engineer's worst "good friends" is the supply house which takes back the articles he claims defective and replaces them without investigating whether the article was originally defective or ruined by misuse. This method of handling claims encourages an engineer to become more careless in his work and works a hardship on all concerned.

The supply houses, and their representatives, are great factors in educating the engineer, but if lax and careless in their business transactions he will gradually become the same in his work. For example, in place of catching the hexagon on the bonnet of a brass valve in the vise, then screwing a piece of pipe into the valve and using it as a lever to loosen the bonnet, he will catch the body of the valve in the vise and try to loosen the bonnet with a monkey- or perhaps a pipe wrench. Then, when the body slips in the vise he will tighten it up and squeeze the seat out of shape, and the valve will leak. This may be either ignorance or carelessness, but it makes no difference, he says the valve is defective and returns it. In order not to lose the business the supply man replaces the valve without a word and junks the ruined one.

How much better for all concerned it would be to take the valve back to the engineer, show him how it had been ruined and how to take it apart, and make him pay for it, as he should. Nearly all manufacturers test their valves before leaving the factory, consequently they have a right to look with suspicion on complaints regarding leakage through the seat.

Some time ago an engineer claimed that three automatic stop and check valves were leaking and didn't open as they should when cutting in a new boiler. They were taken apart and found to be covered with mud, which caused all the trouble. The engineer should have taken these valves apart himself before making complaint.

In another case, where a gate valve was placed in the header between two engines, the first time it was closed it "leaked like a sieve," and complaint was made. Another tested valve was sent, and this likewise leaked. An experienced man was sent, and he found that the expansion in the pipe line was springing the body of the valve. The piping was rearranged and the trouble disappeared. In a new pipe line there is always a lot of pipe scale cuttings, etc., that may lodge in the valve the first time the steam is turned on.

Returning material to obtain new when you are not justly entitled to it is dishonest. You might just as well break into a place of business after nightfall and take what you want. Besides, we pay the bill in the long run.

⁂

## Definite Engineering Education

Attendance at commencement exercises this month brings many rewards to those fortunate enough to hear the distinguished speakers from far and near, but there is one striking consolation for the man who must stick to his daily task while others loll about the campus and drink in good advice in the auditorium. That is the eternal value of scientific principles, both pure and applied, as a mental resource and stimulus to the individual. Thousands of words have been spoken this month upon the subject of technical education and its relation to modern industry. Much of this has been interesting to hear, but a large part of it has been self-evident, with remarks of scarcely more than a commonplace value to the engineer, be he graduated from the school of experience or from the university of books and laboratories.

We have no quarrel with present methods of engineering education, but we do wish to emphasize the surpassing value of concrete studies in contrast to the ocean of generalities poured forth by many commencement speakers at this season. Some of these men rose to the occasion and drew appropriate lessons for the engineering profession from these epoch-making days in the world's history. Others—well the feeling of many a man after sitting through some of these exercises is one of thankfulness for the solid interest and profitableness of definite engineering principles and problems as a field for putting forth one's best powers of thought and expression. Those of us in, or closely allied with, engineering work can rejoice that we do not have to spend three-quarters or more of our waking hours groping about in the fogs of speculative theory which beset the footsteps of so many "educators." How much more interesting it is to stop leaks in the plant, to figure out a method of utilizing more heat units between the turbine-discharge outlet and the feed pump, to rectify a poor valve setting on the basis of a skillful indicator diagnosis—yes, to master the situation in dealing with that oil salesman, or to make the boss's jaw set with satisfaction in showing him an exceptionally good report of station performance!

A man may have gone back to his Alma Mater this year to celebrate some notable anniversary in his life, and yet he may have come away and gone straight to his job again with greater enthusiasm than ever for the principles on which his work is based and greater interest in its puzzling difficulties. He may have been given inspiration for taking up regular work again by speakers of international fame, or he may have been driven back into his own thoughts by the skill with which titled and "degreed" orators enunciated the perfectly obvious. However it may be, there is not the shadow of a doubt that one of the greatest blessings about working in the engineering field, with all that it implies in self and coöperative education, is the necessity of definite aims, of striving toward some concrete attainment. The lasting opportunities before the engineer for the mastery of specific principles and problems put the hypotheses and assumptions of people less accustomed to deal with realities far into the background as objects of tangible achievement.

⁂

## Practical College Work

It is always gratifying to see a college or university with a decidedly practical trend. More and more is this becoming the spirit of the modern educational institutions, as contrasted with the learned, but not always useful, reputations which they once held.

The Oregon Agricultural College is making a first attempt to carry its engineering instruction out to the people of the state. During the past three months lectures and demonstrations have been given to the Portland branch of the International Union of Steam Engineers, with an average attendance by the members of over one hundred and fifty. In addition to the lectures, demonstrations have been carried on at various plants in the city, and a number of experiments and exercises have been conducted by individuals interested. One typical instance resulting from this instruction was a saving of eight per cent. in the cost of fuel in one of the largest plants in Portland.

The subjects taken up this year were "Combustion Control" in connection with the operation of heating plants, and "Refrigeration." This work was given by Prof. F. H. Rosencrants. There was also one lecture in "Electrical Engineering," by L. F. Wooster. The work proved so successful that it will probably be carried forward on a larger scale next year, according to a report of Prof. R. D. Hetzel, the Director of Extension.

While we do not wish to see the spirit of the age too commercial, real efficiency as measured in dollars and cents is, after all, the one for which it pays to strive, and if the colleges can teach us how to cut down the fuel expense in our steam plants eight per cent., it behooves us to give them an audience.

Of course, it does not follow that the savings will be general or that they are always possible. There are many engineers and steam-plant operators who could teach most college professors a great deal about economical combustion. At the same time, the college professors may have come from the ranks and, through the school of experience, know something about firing themselves.

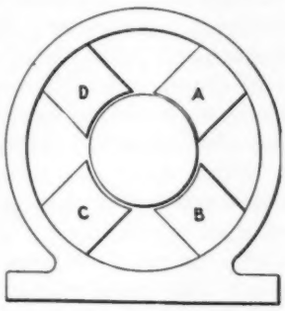
⁂

There is a letter by one of our esteemed contributors on page 852 of this issue that nearly all should read—assistants as well as chiefs. It is about wage increases. Assistants should read it because it will reveal to many what the chief is "up against" when he tries to increase the wages of his subordinates. Chiefs should read it to either remind them of, or acquaint them with, the things they should consider before attempting to add to the payroll burden. Employers realize more and more that good wages attract high-quality labor, and most of them will increase wages when convinced it is deserved. But none will make weekly or monthly donations.

# Correspondence

## Hot Generator Bearing

On starting up a small belted generator that had not been in use for some time the bearing on the commutator end ran hot. The operator, thinking the bearing might be pinching, put liners between it and the cap. Then the bearing got hot quicker than before. When the cap nuts were loosened slightly with the machine running, the shaft was seen to rise out of the bottom bearing and follow up the cap; and the bearing got hot very quickly. This indicated that there was an unbalanced magnetic pull on the armature.



SHOWING UNEQUAL AIR GAP

An examination showed polepiece *A* to have a smaller air gap than *B, C* and *D,* which were all alike. There were a few shims back of the polepieces and by removing those back of *A* the air gap under *A* was equalized with those under *B, C* and *D.* The cap was then put back on the bearing without any liners and pulled down tightly, and the bearing did not go above a moderate operating temperature.

D. N. McCLINTON.

Pittsburgh, Penn.

## Child-Labor Laws

In a recent issue of one of my engineering magazines I noticed under the heading of "Court Decisions," the following statement concerning child labor in Alabama:

**Under a law enacted at the present session of the Alabama legislature and approved by the Governor Feb. 24, 1915, it becomes unlawful to employ any person under 16 years of age in operating or assisting in the operation of any steam boiler or dangerous machinery.**

This evidently is a first step (and a rather weak one) in the right direction, for which the engineers in that state should be thankful, but if the law has only reached that stage where children are prohibited from acting in the capacity of engineers, then the engineers of that state have a long, hard road to travel before they can expect to get a safe and sane license and boiler-inspection law and the recognition which is due their position.

It is my opinion, and I believe that there are many others who will agree with me, that children of 16 years should be in school. Certainly, the work and responsibility of operating a steam boiler and engine should not be intrusted to a child.

In Alabama there are comparatively few boilers as compared with Massachusetts and other manufacturing states, and probably for that reason sufficient pressure has not been brought to bear to put through a reasonably safe law in regard to the operation of power-plant machinery. When we consider that Massachusetts, with its present rigid laws in regard to the construction, inspection and operation of boilers and examining and licensing those who are to have charge of them, is not satisfied with its present laws, and is trying to enact more adequate and in some instances more rigid ones; that Ohio, which now has rigid boiler-inspection and engineers' license laws is about to adopt the new regulations as proposed by the A. S. M. E.; that Wisconsin has already adopted these laws, and some other states and municipalities are contemplating the same step—it does seem that the present situation in Alabama is many years behind that of the other states.

These facts bring out the question, Are the boilers in Massachusetts, Ohio or Wisconsin more dangerous or the men as a rule less proficient than those of Alabama and some other states where there are no inspection and license laws? It is probable that the reverse is the case. Is there any right-thinking employer in any of the states which have any semblance of inspection and license laws (no matter how opposed he may be to the present laws of his state) who will admit for a moment that a boy of 16 or 17 years of age is a competent person to have charge of his engines and boilers? I think not. He may be satisfied to have these lax laws by means of which some other employer may hire the boy, and thus make it possible for him to get a man at boy's wages.

Then there is another phase of the subject which appeals to most employers, aside from the safety of the plant, and that is efficiency. It is well known that it often lies within the power of the engineer to regulate the cost of producing power. For this reason the progressive employer insists on having a man of mature knowledge, judgment and experience in the power plant, to say nothing of a 16-year-old boy who cannot possibly have acquired these qualifications.

It seems to be the aim of some of the employers in some of the states where the laws in this respect are rather lax or where there are none at all, to vigorously oppose legislative bills that come up in regard to boiler-inspection and license laws on the grounds that they are unnecessary and will cost them more money through the engineer's being able to control the supply of engineers to some extent, and of the necessity in some cases of getting other men. They can only see the almighty dollar that they may have to pay for the services of a competent man, to one who has to prove to an exacting board of examiners that he is competent to safely and efficiently operate this class of machinery before he is allowed to have charge of it. But they lose sight of the double eagles that will come to them through the more efficient operation of the plant by the man who can prove that he has the skill to do it.

As time goes on, the laws that govern the requirements of engineers become more exacting, and the employer, realizing the importance of the engineer's position, demands more efficiency in this department, and only those men who are persistent in their efforts to improve

their conditions and who are willing to work conscientiously for their employer's interests, will succeed in holding the best positions in the engineering field.

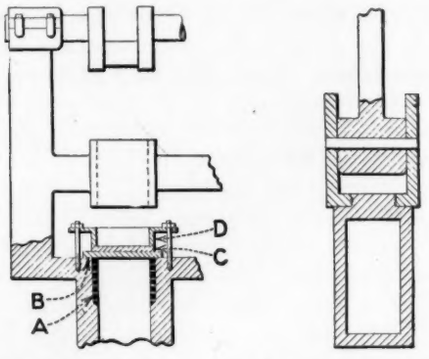
J. C. HAWKINS.

Hyattsville, Md.

## Running a Crippled Pump

The threads on one plunger of a geared triplex pump gave way at the point where it screwed into the crosshead.

In order to keep the machine running, the disabled plunger, crosshead and connecting-rod were removed and the cylinder closed, as shown. In the illustration *A* is the




PLUNGER REMOVED AND OPENING CAPPED

plunger packing, which was not removed, *B* is a rubber gasket covering the opening in the end of the cylinder, *C* is a piece of sheet metal under the gland *D* to reinforce *B*. When these parts were assembled and tightened down, the pump was kept running with the two good ones until a new plunger could be made to replace the disabled one.

The construction of the plunger and crosshead is shown, in which the plunger screws into the crosshead which is cylindrical and runs in a bored guide.

EARL PAGETT.

Coffeyville, Kan.

## Increasing the Mens' Wages

It sometimes falls to the lot of the chief engineer to approach his superior relative to an increase of pay, not for himself, but for the men of the plant. The task is not an easy one at best. Many a plant owner or manager who is personally a good boss to work for finds it necessary to put such requests "on file." Unless an engineer can show his superior why it will be good policy to increase the existing wage outlay, he will do well to refrain from asking for it.

Hard-headed business men do not increase wages without good reason. The engineer must never forget that to the man of affairs the power plant is usually incidental, and it is a mistake not to appreciate proportion when seeking to add to the payroll. The faithful work of an engineer through many years makes the presentation of recommendations a fairly easy matter so far as the continuance of friendly regard goes. "Bill says the firemen ought to have 15 cents a day more," says a manager of this kind, "and I guess he's right. He has been cutting the unit fuel cost 10 per cent. in the past six months. He tells me the peak is broadening and that we now have to run No. 6 and No. 7 boilers through the noon hour, when the boys used to ease off a bit more than they can today. Anyhow, it's Bill's job to know his men, and so long as the kilowatt-hour expense goes down, I'll back him in sharing the profits with the men."

This is not the kind of manager with which some engineers have to deal, as is shown by the following questions asked in a recent case where the chief thought his men ought to have a further advance in pay because of their faithful work, their punctuality, willingness to see the boss through any troubles and increasing familiarity with the service requirements.

"The work has not changed or increased since the last raise, has it? The men have had frequent raises in pay in the last decade, haven't they? Do you recall any class of men in your station that did not share in the previous increases? The hours have been reduced, have they not? Can you point to any specific increase in the men's efficiency since the last raise? Does the mere fact that your firemen understand English better justify this company in giving them more money? How many men have you today in this plant that were not on the payroll at the time of that last increase? Were not the men just as busy then as now? Have you any more or different machines now? Has the output increased enough to make it perceptibly harder for any man to do his daily work, and have you had to hire any more men to meet this condition? What sort of repair jobs have come up that have been handled quicker than before by the men as the result of their greater familiarity with the station and at how much less cost? Don't you pay the 'going rate' of wages in this station?"

By this time the engineer is likely to be reduced to a point where a reply is impossible unless he has anticipated just such objections. There is no use in considering the manager as a leather-hearted tight-wad, for he is only trying to protect the investor, although sometimes protecting the investor and sharing the profits may be parts of the same policy.

H. S. KNOWLTON.

Cambridge, Mass.

## Operating a Pressure Pump without an Accumulator

Some time ago we installed a large pump to maintain a pressure of about 2200 lb. on the rams of a number of hydraulic presses. The accumulator on the line between the presses and the pump was weighted by building a cement block upon it. Subsequently, it was found that the weight was insufficient, and after some careful figuring the fact was brought out that it would be necessary to remove the whole cement block in order to get room to put on the pig-iron weights that our pressure called for.

This looked like a big and expensive proposition, so I advised running without an accumulator. This was objected to by the superintendent, and to my surprise the pump agent sided with him, but later they told me to go ahead and try it. I am pleased to say that after a year's operation in this way, the pump is giving good service, and I have less trouble with it than with its mate, which is attached to an accumulator.

I calculated that 88 lb. pressure per square inch, acting on the 10-in. steam piston (having an area of 78.54 in.), exerted a total pressure of 6911 lb.; operating a 2-in. plunger on the water end against 2200 lb. per sq.in. would

just balance. It was therefore necessary to raise the boiler pressure slightly to overcome friction.

This pump is of the single-cylinder type, and we experienced no trouble with it until about two months ago, when the pressure fell at each stroke, and as a uniform and constant pressure is called for in our work, it was necessary to find the cause. The piping and joints were examined for leaks, the packing was renewed, the valves in the pipe lines were tested, and the pump valves were removed and inspected, but still the pressures varied. I decided that the trouble lay in the discharge valves, but was unable to see what it was.

On Sunday I thought it would not be amiss to give the valves a little grinding, although they did not seem to need it by any means. The next morning the pump acted much better and the variation in pressure was much less. Here was the cause, and a very small cause it was at that. Since then I have made a thorough job of the grinding, and the pump is giving splendid service.

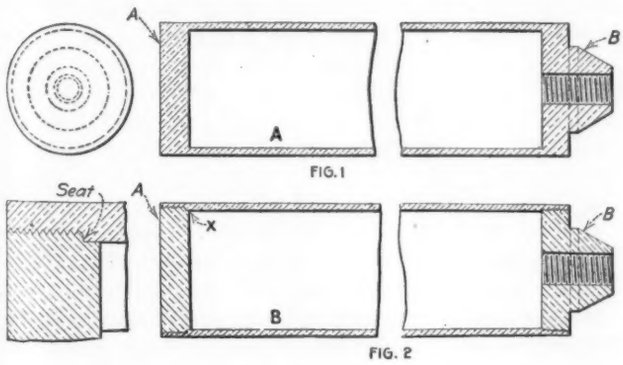
While grinding does not appear to change the surface of these valves, results show that it does. I believe grooves are caused by the action of the water under high pressure, and while they are not to be detected by the eye or touch, under a glass they are easily seen. Engineers who have not had such experience will be surprised to know how rapidly water under high pressures can get through minute holes.

A. D. Palmer.

Dorchester, Mass.

## Renewing Pump Plungers

The illustration shows a method of renewing the plungers of an outside-packed plunger pump. Those furnished by the manufacturer are of cast brass, the shell being from ¼ to ½ in. thick, according to the size of the pump and the working pressure. Fig. 1 shows the original plunger and Fig. 2 the new one. The heads *A* and *B* were cut off, turned and threaded as shown in




Pump Plunger Made of Pipe

Fig. 2. The shell was replaced by a length of extra-heavy seamless bronze pipe, seated and threaded to take the heads *A* and *B*.

The cost of the new plunger, including material and labor, is one-half that of the one furnished by the manufacturer. This difference in cost is due to the fact that in making the castings there is always difficulty in keeping them free from blow-holes, and another irregularity, the shifting of the core.

The life of the cast-brass plungers does not in any way compare with those of seamless bronze pipe, and when the latter is worn down, it is only necessary to replace the shell.

Herman Fiebig.

Brooklyn, N. Y.

## Crankpin Failure

Referring to the article by F. F. Jorgensen, on the subject of crankpin failures in the issue of May 25, on page 720, I consider that the pin was not large enough in diameter for a cylinder of the size given (24 in.). There is an approximate moment of 2½ in., therefore,

$$55{,}000 \times 2\tfrac{1}{2} = 137{,}500 \textit{ in.-lb.}$$

The section modulus of 4½-in. diameter equals $0.98 \times 4\tfrac{1}{2}^3 = 8.91$, say 9.

$138{,}500 \div 9 = 15{,}278$ *lb. stress per sq.in. of pin.*

This is too high a stress for such work as hoisting. The normal stress should not be more than half of this, say 7000 lb. per sq.in.

The fillets are good and should be on all such pins. A still better design is to countersink the collar in the crank from one-quarter to one-half inch, and more where possible. I would suggest that a larger pin be made and put in before another accident occurs, because a larger pin is really necessary, and no doubt the crankpin box is of such design that the bore can be somewhat increased.

R. G. Cox.

Cleveland, Ohio.

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The addition of fillets is undoubtedly an improvement on the old pin that failed, but the main trouble is that the pin is too small for the load. The information given indicates that the maximum pressure upon the pin was 54,000 lb. and the fiber stress in the pin at the point where it broke was 15,100 lb. per sq.in. As the stresses in a crankpin occur twice in each revolution, it is necessary to use a low fiber stress, generally between 8000 and 12,000 lb. per sq.in., according to the grade of steel. Assuming a fiber stress of 9500 lb. per sq.in., the new pin should be 5¾ in. diameter. Heat-treated or alloy steel may, of course, be subjected to higher stresses. The impact load is sometimes very high, and this is an added argument for designing the rods and pins of such engines for low fiber stresses.

A. D. Williams.

Cleveland, Ohio.

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It is evident that the absence of a fillet contributed much toward the failure. In locomotive practice, failures occur even with liberal fillets. I recall a series of pin failures on 18x24-in. eight-wheel engines on a Middle West railroad at one time. The engines were some eight years old at the time, and well cared for. The back pins broke off just inside of the pin hub, and the fractures as a rule resembled the illustration shown on page 720, May 25.

The principal part of the fracture was toward the center of the wheel, a smaller break was on the outside of the pin, and the pin hub was chafed bright for one-half to three-quarters of an inch in from the face of the pin hub, indicating a bending of the pin for some time prior to fracture. The face of the fracture being quite smooth at the outside of the pin and gradually becoming coarser

toward the place of final rupture, shows the characteristic fracture of the material of which the pin was composed. The original wrought-iron pins were replaced by either wrought-iron or forged steel in different engines, but both of the new kinds broke, some in as short a time as six weeks. They generally broke about one-quarter to one-third of the pin's diameter before the final rupture took place.

After the failure of the new pins of the same size as the original, the pin hubs were bored one-quarter inch larger and case-hardened pins of Low Moor iron were put in. There were no more failures for about a year afterward while I was working there. The cause of the fractures was evidently due to the thrashing of the rods at high speed, although on that type of engine we did not have any trouble from breaking main pins, notwithstanding they carried the two rods and had the piston pull to reckon with. On another road I saw a number of main-pin failures, and the fractures showed the same general features.

When the brasses are removed, a coating of white-lead paint on a freshly wiped pin will disclose cracks, the paint becoming discolored by the oil in the cracks. However, this test will be of no value where the fracture is within the pin hub.

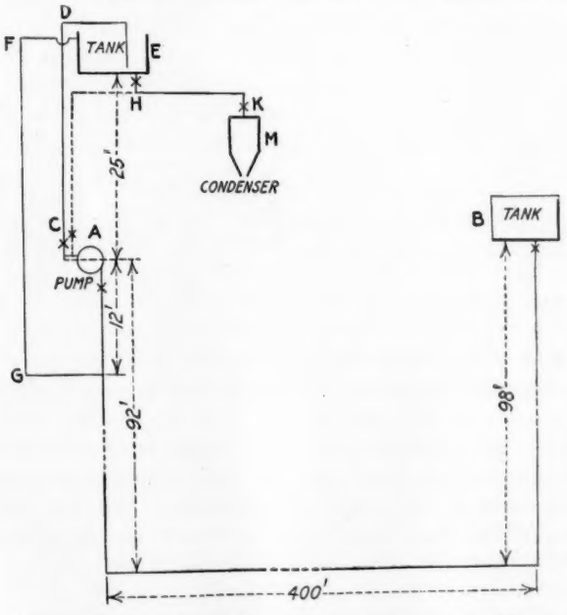
C. W. Haynes.

Rome, N. Y.

## Centrifugal Pump Became Air Bound

The centrifugal pump *A* draws salt water from the tank *B*, through 590 ft. (400 + 92 + 98) of 12-in. pipe. When the machine is stopped there is about three pounds' pressure on the suction side at the pump.

The pump discharges through line *CD* into tank *E*. The latter supplies salt water to the condenser *M* through




Piping Diagram of Pump, Condenser and Tanks

pipe *HK; F* is an overflow pipe. This was intended to eliminate hand regulation of the pump discharge; if the quantity was too great it merely overflowed from the tank back through *F* into the suction of the pump. However, the water flowing back through *F* sucked in air. This was drawn through *F* into the pump, causing it to become air bound, and it would deliver no water.

Another thing contributing to the air binding was the fact that when the pump was working up to capacity there was a vacuum of about 15 in. at its suction due to the friction of the 590 ft. of piping. When this vacuum exceeded the head due to *BG*, air would be sucked in through the pipe *F*.

The above conditions were remedied by doing away with tank *E* and pumping directly to the condenser through pipes *CHK* (shown dotted) regulating the capacity by means of valve *K*.

Frank McMorrow.

New York City.

## Sand for Hand Cleaning

Power-plant men usually have a hard time cleaning their hands. At our place we keep a supply of fine sand by the sink, which we apply to our hands after soaping them well. This takes the grease off without injuring the hands. I have always been troubled with chapped hands in the winter, but scouring them in the sand once or twice a day overcomes this trouble.

J. O. Benefiel.

Anderson, Ind.

## An Unusual Piston Failure

In the issue of May 18, page 689, J. W. Dickson describes a unusual piston failure and asks to hear from readers who have had like experiences. A similar accident was related in Power about five or six years ago, and since then this has occurred twice in the plant of which I have charge. Both were in 22-in. pistons on low-pressure air compressors of different make. In neither case was any damage done to the compressor. In the first the damage was repaired in the way described by Mr. Dickson; in the second a new piston was required, which the builder supplied without charge.

No time was lost in finding the cause of the pounding, thanks to the article in Power, which was fresh in the writer's memory when the first failure occurred. The trouble in each case was due to core iron (used to stiffen the sand core) being left in the piston when it was cleaned, this cleaning out of the core being a difficult matter on account of the small opening provided for the purpose. The pounding was caused by the increased clearance volume.

P. L. Werner.

McKeesport, Penn.

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One morning a number of years ago, a sudden loud "thump" inside of our 16x36-in. engine shook things up pretty well. The chief shut the engine down promptly, took off the cylinder head and found that a nut from one of the adjusting bolts between the bull ring and piston had worked off and worn a hole through one head of the piston and nearly through the other. These places were drilled out and plugged, after which the engine ran as well as ever.

Later we had an experience on a condenser pump similar to that described by Mr. Dickson and repaired it in the same way.

W. O. Perkins.

Bristol, Conn.

We had a very similar accident with a straight-line steam compressor. The piston in the steam end was of the built-up type, and two of the centering capscrews worked loose. One wore through the follower plate (which was one inch thick), fell out into the crank end of the cylinder, and broke the follower plate. A new cored piston was cast and put in place of the built-up type, and the compressor has since been running very satisfactorily.

P. F. Oates.

Santa Barbara, Chih., Mexico.

## A Warning Sign

The illustration shows a safety or danger sign used in our plant. When the men go to work on shafting or belts they are instructed to hang this sign on the throttle valve and waterwheel gate as a warning to the engineer and others not to start any prime mover, and every man working on the job must sign his name on a pad near-by. When he has finished with his work he must cross out his name and the last man off the job is to take the sign or signs down. Our danger sign is 8x23 in., made of galvanized iron painted with aluminum, with a red border and red letters.

Metal Danger Signal

A. D. Skinner.

Chadwick, N. Y.

## Peculiar Induction-Motor Accident

I was called upon recently to repair a motor that had met with a rather unusual accident. It was a 100-hp., three-phase, 440-volt machine operating a gyratory crusher in a rock quarry. Heavy rains had caused a slide, and a rock had fallen from the quarry face through the motor room, breaking one of the leads to the auto-starter. This caused the no-voltage release to act, cutting out the motor at the auto-starter. A greater mass of rock was loosened by the first slide, and about five hundred tons crashed through the motor room, covering the motor entirely. In a short time smoke was seen coming up through the débris, and someone cut off the power at the quarry substation. Upon uncovering the motor, it was found apparently uninjured, but the auto-starter was seen to be in the "starting" position. Upon test, the motor showed forty badly burned coils.

Investigation showed that the first slide had cut out the motor safely, but the second slide (only a few seconds later) must have struck the auto-starter handle so as to throw it into the "starting" position, and to wedge it there. The motor could not start for at least two reasons: First, because one lead had been broken by the first slide, leaving the motor on single-phase; and second, because the machine was blocked by the rock from the second slide. The auto-starter was so wired that there were no fuses on the starting side, and the substation fuses were too large to relieve the motor, so it had to stand with the one phase hot, causing damage to forty coils. The auto-starter was uninjured.

The worst coils were cut out, and the others repaired so that the motor was put into commission 14 hours after the accident.

D. D. Smalley.

Bagley, Calif.

## Single-Unit Power Plants

A short time ago the writer was asked to investigate the proposition of installing a municipal electric-light plant in a small town, and after determining as nearly as possible the probable load, it was decided that the conditions would warrant the installation of two 75-kw. units.

Several types of plants were considered, but the one which attracted special attention was the proposal to install a 125-hp. anthracite gas producer and a 100-kw. generator, to which would be connected two 2-cylinder gas engines of 70 hp. each, one on either end of the generator and connected thereto through a clutch. The principal advantage claimed for this arrangement was that, the gas engine being uneconomical at light loads, either engine could be used separately when the load was light, thus increasing the load factor toward the most economical point. Then, as the generator load rose above the capacity of one engine, the other could be cut into service and both run in parallel. It was claimed that this plan had been tried and found successful, even when running alternators in parallel, and that no trouble was experienced in the regulation.

The load to be handled was residence, store and street lighting with a small intermittent motor load on the water-works pumps. It would average about 50 kw. at the start, with a peak during the evening. The system arranged in this manner would allow one engine to be operated during the regular load, alternating every day and using both on the peak. This would also give time to keep the engines in good running condition.

Another advantage claimed was that, as only one generator would be used, the first cost would be less, including a smaller switchboard and less wiring. It was further proposed that when the load had increased to an average of 80 or 100 kw., a second unit consisting of one engine and one generator (with an additional producer) could be installed and operated at about full load. The combination unit would then be held as a reserve and used to help out on the peak load, running one or both engines as the conditions required. This plan would insure the engines' being fully loaded at all times and would reduce the coal consumption per kilowatt-hour to the lowest point.

Arguments that may be advanced against this plan are that the system consists of outside pole lines and there would be considerable danger from lightning. The generator and switchboard would of course be protected by lightning arresters, but there is a possibility that the generator might be damaged from this source, which would put the entire plant out of commission. An alternating-current generator as a rule is not as liable to be damaged,

in the machine itself as a direct-current machine, there being no commutator; but trouble might develop, either in the machine itself or in the exciter, which would put the entire plant out. It is probable that no breakdown service could be provided, as the idea is to take the load away from the central station at the expiration of the franchise.

Another proposition was to install two 100-hp. boilers and one Corliss engine to operate at 125 lb. and 150 r.p.m., and direct-connected to the generator. The builder claimed that this arrangement could be depended on to run 18 or 24 hr. a day, 7 days a week, and with only a few minutes' stop once or twice a week for keying up and other minor adjustments. This would fill the requirements of the plant for several years to come or until money was available for a second unit. It must be remembered that these plans were not advocated as being the best, but to get a plant with the money available at the time the central-station franchise expired.

The greatest objections to this single-unit steam plant in addition to generator trouble is that in order to carry the peak and the increasing average load, it would be considerably underloaded a greater part of the time, and the steam consumption would be correspondingly high.

The matter has not yet been settled. Usually, it has been considered poor policy to depend on one unit for continuous operation, although the writer knows of several instances where this was done for a number of years, and the engine, as a rule, was stopped only half an hour at noon once a week, running 24 hr. a day and carrying approximately full load.

J. C. Hawkins.

Hyattsville, Md.

## Another Combustion Suggestion

There appear to be two principles that might be used to improve the action of boiler furnaces in addition to those already utilized. They have been used in analogous arts and might be availed of to make the combustion of the fuel used with boilers more efficient.

The first is based on the old method of brightening a fire by means of a poker or iron. It consists in placing the iron in a dull fire where the combustion is most prominent and leaving it there. The iron accumulates and stores the heat and not only prevents the fire from dying out, but conveys the heat to other parts of the fuel. It also takes up heat that would otherwise pass off in the gases. When the iron becomes red-hot it acts like a burning coal, except that it does not burn out and stop heating.

This principle could be used in boilers by placing a number of rods across the furnace so they would come in contact with the fuel above the grate. They could even be extended along the path of the furnaces through the boiler parts, so that the gases would have heat supplied to them during the entire period. The rods, being conductors, would supply heat to the gases at all points at about the same temperature as they (the rods) were at, in the furnace. The rods would deteriorate, but that would not of itself be an argument against their use.

If the rod was hollow, particularly in the portion that was in the furnace, it could be used to convey the draft or air to the furnace where it was needed and without cooling the fire, and at the same time the air would tend to keep the rod sufficiently cool to prevent melting.

The second principle consists in using materials that will raise the temperature of the fire and that do not burn themselves—for instance, chalk, unglazed ware, etc. This principle is like that used in an incandescent gas burner. It might be employed by mixing the material with the fuel or by installing it in some back part of the furnace so as to heat the gases or promote combustion in some special part of the boiler. In any case, it would serve to increase the efficiency of the fuel used and to stabilize the operation of the boiler in somewhat the same way that a flywheel does the action of a reciprocating engine.

These are theoretical suggestions. Can they be made of practical use?

A. P. Connor.

Washington, D. C.

## Differential Draft Gage

Differential draft and air-supply gages are inexpensive in comparison with the saving they represent. Time is well spent in their upkeep. Imperfect connections to furnace or ashpit thwart their purpose.

Water has too variable a capillarity to be employed as an indicating fluid. Kerosene may be used in an emergency. The best liquid is a mineral oil of 39 degrees gravity, Baumé scale, at 60 deg. F. and specific gravity about 0.834. This oil evaporates slowly, is a good lubricant and will recede to the zero mark. To set the differential gage both ends should be free to the atmosphere. The liquid should be poured carefully into the reservoir end until the zero mark has been reached.

No set of rules can be laid down as to the amount of draft to be carried, as load, fuel-bed thickness and other factors affect each case differently. A near approach to a balance seems to be the aim in many plants. It is true that a high degree of perfection in combustion can thus be attained and a high $CO_2$ record made, but for practical operating conditions I prefer at least 0.02 or 0.03 in. of water over the fire. Of course, a pressure of 0.06 or 0.07 in. or even 1.02 in. under the fire will do no harm if the firebed is well sealed.

Edward T. Binns.

Philadelphia, Penn.

## Removing Scale from Oil-Engine Jacket

Operators of oil engines often experience trouble with the cooling water scaling up the cylinder jackets; in fact, in some localities the jacket almost fills with scaly deposits in a few weeks. The method usually employed is to allow a dilute sulphuric-acid solution to remain in the jacket for a few hours, thereby loosening the scale. This is effective, but rather severe on the cylinder walls.

A short time ago the writer met with this trouble and eliminated it by using graphite mixed with oil and placed in an ordinary hand oil pump connected to the cylinder jacket. The engineer operating this engine gives the pump two or three strokes a few times each day. It seems that the graphite acts upon the jacket in the same manner as on boiler tubes.

L. H. Morrison.

Fremont, Neb.

# Inquiries of General Interest

**Estimating Piston Speed of Duplex Pump**—In a duplex pump how is the piston speed determined from the length of stroke and the number of revolutions per minute?

F. P. K.

The term, piston speed, has reference to the average velocity of the water pistons, and when each side makes the same length of stroke the average piston speed in inches per minute would be found by multiplying the length of stroke in inches by two, and by the number of revolutions per minute. This product divided by 12 would be the average piston speed in feet per minute.

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**Drilling Small Holes in Glass**—What is a good method of drilling small holes in glass?

G. W. K.

Small holes can be drilled in glass by employing a flat drill lubricated with turpentine. In drilling small holes through thin glass, care should be taken that the drill does not break through and thereby shatter the glass. Where possible, the drilling should be done from both sides. Another method is to employ a drill made of brass pipe having its end cut off square and one or more slots in its side for the introduction of flour of corundum.

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**Stability and Isochronism of Governors**—What is the difference between stability and isochronism of steam-engine governors?

G. R.

A governor is said to be stable when it assumes a definite position for each particular speed and when a change of speed is necessary for a change of position, while a governor which is in equilibrium at but one speed is said to be isochronous. Perfect isochronism would be impractical, as the slightest increase in speed above the normal would result in cutting off the steam, accompanied by a sudden decrease of speed, following which the steam valve would open wide, thus giving rise to extreme fluctuations.

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**Water Hammer in Steam Pipes**—What is the explanation of water hammer in spaces containing steam, and particularly the snapping and cracking noise often heard in steam pipes?

R. W. R.

Water hammer is attributed to the impact of particles or slugs of water upon each other or against the sides of a pipe or other containing vessel, due to the formation of vacuous spaces that result from cooling and condensation of the steam. Water is comparatively incompressible, and a continuation of the high velocity of the steam toward such a vacuous space after condensation has taken place and the movement of slugs of water toward those spaces at high velocity by the elastic force of the steam result in violent impacts, similar to those occurring when inelastic bodies impinge upon each other at high velocities.

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**Size of Steam Pipe**—Allowing a velocity of 5000 ft. per min., what diameter of steam pipe would be required to pass 6500 lb. of steam per hour at a gage pressure of 80 lb. per sq.in.?

B. E.

Referring to the steam tables, it is found that the specific volume of dry saturated steam at 80 lb. gage, or 95 lb. absolute, is 4.65 cu.ft. per lb., and as the flow would be

$$6500 \div 60 = 108.33 \text{ lb.}$$

of steam per min., the volume flowing per minute would be

$$108.33 \times 4.65 = 503.73 \text{ cu.ft.}$$

and the required cross-sectional area of the steam pipe for a velocity of 5000 ft. per min. would be

$$\frac{503.73 \times 144}{5000} = 14.5 \text{ sq.in.}$$

which corresponds to

$$\sqrt{\frac{14.5}{0.7854}} = 4.28 \text{ in.}$$

diameter, and therefore 4½-in. steam pipe would be the nearest commercial size suitable.

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**Relative Merits of Belt Dressings**—In what particulars should the relative merits of belt dressings be considered, and how can they be practically compared?

E. W. C.

The leading merits of belt dressings consist in (1) increasing the coefficient of friction between the belt and the pulley, enabling transmisison of a given power with a lower belt tension; (2) increasing the pliability, and (3) prolonging the life of the belt. The relative friction can be practically determined by treating each half of the length of a belt with one of the dressings or by applying the dressing to only one half for comparison with an untreated half, and, with the belt in use, observing which half first shows slippage when the belt is gradually loaded to its transmitting capacity. Or, after use for some time, the relative coefficients of friction can be approximately determined by alternately hanging the belts over the same pulley, and determining which condition requires the greater load to be suspended from the belt over one side of the pulley to slip the belt in raising a given weight suspended from the belt over the other side of the pulley. Relative pliability is made apparent by observing which belt forms a smaller loop when folded over on itself, or when equal lengths of each belt are gathered and suspended. The effect of dressing on durability of a belt can only be determined by test of time and usage.

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**Volume of Air for Burning a Pound of Coal**—What volume of air is required for combustion of a pound of coal?

J. R.

The weight of air required is given approximately by the formula,

$$\text{Weight of air in pounds} = 12C + 35\ (H - \frac{O}{8})$$

in which C, H and O represent the parts of a pound of carbon, hydrogen and oxygen in a pound of the coal.

Applying the formula to the analysis of most coals will show that about 12 lb. of air is required for combustion of a pound of the fuel, and as one pound of air at 62 deg. F. has a volume of 13.14 cu.ft., then $12 \times 13.14$, or about 158, cu.ft. of air will be required to burn each pound of the fuel. For certainty, however, that the carbon will meet with an abundance of oxygen, it becomes necessary to admit an excess of air, depending on the draft, and the weaker the draft the more the excess required. Hence, with chimney draft it is usual to supply about 300 cu.ft. of air per lb. of coal, and with forced draft about 200 cu.ft. of air per lb. of coal.

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**Discharge of Water from Hydrant**—What quantity of water would be discharged per minute through a short 2-in. pipe connected to a fire hydrant in which the pressure is 60 lb. per sq.in.?

M. A.

The rate of discharge would depend upon the roughness and length of the pipe and the pressure at the entrance of the pipe. Assuming that the pressure 60 lb. per sq.in. is maintained while discharge is taking place, then as 60 lb. per sq.in. would be equivalent to

$$60 \times 2.3 = 138 \text{ ft. head}$$

and as the theoretical velocity in feet per second due to the head would be given by the formula,

$$v = \sqrt{2gh}$$

in which

v = Velocity in feet per second;
g = 32.16, the acceleration of gravity;
h = 138;

then,

$v = \sqrt{64.32 \times 138}$, or about 94.2 ft. per sec.

If the pipe has a smooth bore and a length 3 to 3½ times its diameter, that is, 6 to 7 in. long, and has a smooth, square entrance end, then the actual velocity of discharge will be about 81 per cent. of the theoretical, and as the cross-sectional area would be

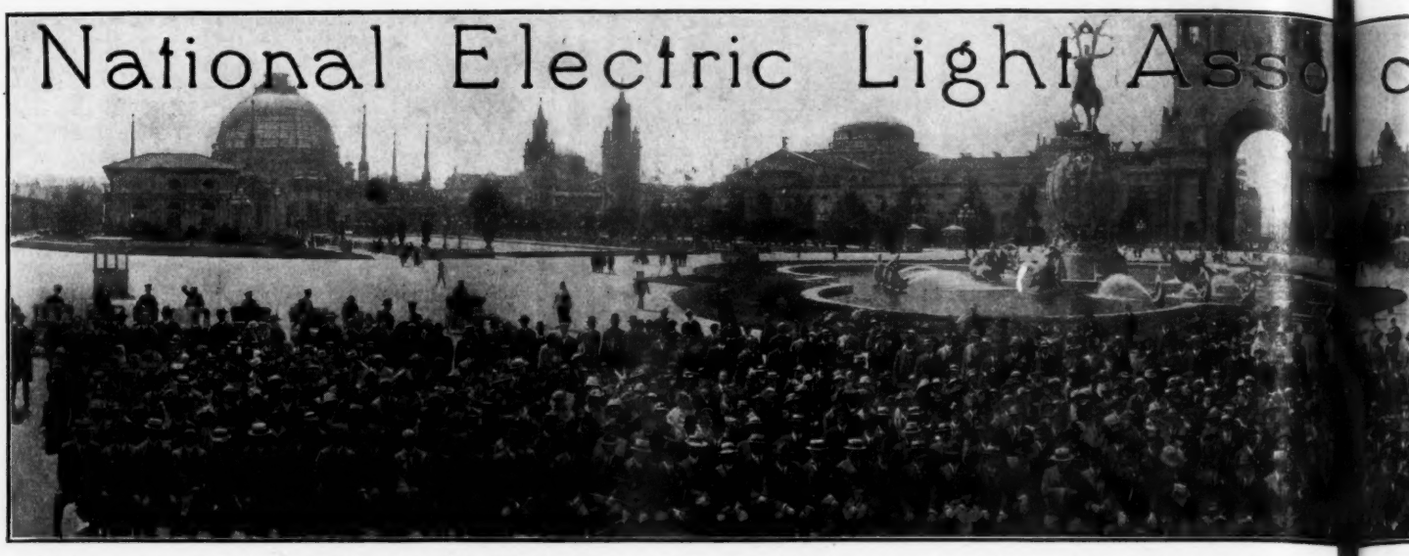
$$2 \times 2 \times 0.7854 = 3.1416 \text{ sq.in.}$$

the discharge would be approximately

$$\frac{0.81 \times 94.2 \times 12 \times 3.1416 \times 60}{231} = 747 \text{ gal. per min.}$$

It is assumed that the pressure at the entrance of the 2-in. pipe is ascertained from indication of an accurate pressure gage during the discharge, as that pressure is not to be confused with the static pressure which exists only when no discharge is taking place.

# National Electric Light Asso



With a registration of over one thousand, the thirty-eighth annual convention of the National Electric Light Association at San Francisco, June 7-11, was an unqualified success. The eight-story building, "Native Sons of the Golden West," served as headquarters for registration and meetings, and the Hotel St. Francis, adjoining, cared for most of the delegates and was the center of the social features of the convention, especially the reception given on Monday night by the president, H. H. Scott. On the same evening was dedicated the "Temple of Light," an Ionic colonnade erected around the Dewey monument in Union Square. This was turned over to the visitors by John A. Britton on behalf of the local members, and President Scott accepted it on behalf of the convention.

At the opening session on Tuesday morning, the visitors were greeted by Mayor Rolph, of San Francisco, and by John A. Britton, general manager of the Pacific Gas & Electric Co., who briefly outlined the progress of the Pacific Coast States, with special reference to the important part played by electricity in their development.

Response was made by President Scott, who in the course of his address pointed out the great decrease in the price of electric service during the past 15 years, whereas the price of most commodities had increased. This had been due to increased efficiency in production and to more efficient lighting, the public having derived the benefit.

The remainder of the morning was taken up with the reports of the secretary and of several committees. T. C. Martin, as chairman of the Committee on Progress, dealt with the present conditions of the electrical industry, pointing out a steady increase in spite of the recent business depression, although there have been practically no additions to the number of large central stations during the past year. The second part of the report (read at the hydro-electric session) was devoted to hydro-electric and transmission work, and discussed the pending national legislation on conservation. It suggested that the law be framed so that the banker shall know reasonably well to what extent the investor is protected and to what extent he must accept risk. Opinions were quoted from a number of men associated with hydro-electric work, notably Hugh L. Cooper, who stated that within the past 10 or 12 years hydro-electric plants aggregating over 600,000-hp. capacity had either been through receivership or had proved bad investments.

## FIRST TECHNICAL SESSION

The first technical session was held on Tuesday afternoon, at which were read the reports of the committees on Meters, Electrical Apparatus, and the Grounding of Secondaries, as well as two papers—one on "Application of the Diversity Factor," by H. P. Gear, and the other on "Features of the Lighting of the Panama-Pacific Exposition," by W. D'A. Ryan, illuminating engineer of the Exposition.

In the report on electrical apparatus, attention was called to the introduction of the phase-advancer in performing the same functions as the synchronous condenser in connection with inductive motor loads. While condensers serve primarily for regulating a complete installation, the phase-advancer provides an economical means for regulating the power factor of an individual motor. Among the recommendations of the committee were the use of electrolytic arresters with rotary converters and suitable methods of grounding the converter frames. Modifications of the rules of certain member companies to conform to those of the majority with regard to motor connections was urged, as this would greatly simplify the problems of manufacturers and distributors of standard commercial motors.

## FIRST ACCOUNTING AND COMMERCIAL SESSIONS

Simultaneously with the first technical session were held the first accounting session and the first commercial session. The order of business of the former included an address by the chairman, H. M. Edwards, and reports from the Library Committee, the Question Box Committee, the Committee on Uniform System of Accounts, and a paper by L. R. Reynolds on "Some Opportunities of Public-Utility Accountants."

The commercial section, after listening to an address by the chairman, Douglas Burnett, heard the reports of the committees on Foreign Relations, Finance, Publications, the Education of Salesmen, and the Commercial-Department Terminology.

On Wednesday morning the association listened to an address by President Moore of the Panama-Pacific Exposition, who reviewed the hydro-electric development on the Pacific Coast and spoke of the electrical illumination at the Exposition. He said that about 850 conventions had chosen San Francisco for their place of meeting this year.

Following President Moore's address were held the first hydro-electric and second technical sessions, the second commercial session and the second accounting session. Chairman Wagner called to order the hydro-electric and technical sessions and the report of the Hydro-electric Committee was read by Mr. Downing, in the absence of the chairman, R. Bump.

## REPORT ON PRIME MOVERS

The report of the Committee on Prime Movers was next read by Mr. Coldwell, in the absence of Chairman Moulthrop. The report called attention to the improvements in the design of surface condensers during the past year and also to the increased economy obtained by large steam turbines. Two new stokers of the underfeed type for high capacity were described, and considerable space was devoted to the subject of economizers. The steady increase in the rate of evaporation, with a consequent increase in the volume and velocity of the flue gases and a somewhat higher temperature at the boiler exit, together with the improvement of condensing apparatus, producing lower vacuum and lower hotwell temperatures, have created conditions more favorable to the use of economizers. Under "Gas Power," figures were quoted to show that there are vast quantities of fuel-oil in the United States and in Mexico and that there is much activity in Diesel-engine work among American manufacturers. The gas-engine situation however, seems to be little changed from that of last year; this also applies to the gas producer.

In discussing the report, Henry Hull, of the Puget Sound Traction, Light & Power Co., of Seattle, stated that it had been the experience of his company in burning low-grade, highly volatile lignites, such as are available on the Pacific Coast, that the best results were obtained by the use of continuous chain grates of large area installed in furnaces with dutch ovens. He believed it imperative that the coal be of uniform size to prevent occurrence of holes in the fuel bed and to secure a uniform fire; also that it is necessary, in using a chain grate, to employ a free-burning coal, as any tendency to coke will give trouble from jamming and piling up at the back of the furnace.

# ciation At The Exposition

In the speaker's opinion, the use of economizers depends entirely upon the individual conditions. In plants operating with steam-driven auxiliaries and where leaks in boiler settings are minimized and baffling kept tight, the advisability of installing economizers appears doubtful. He believed that if more attention was given to utilizing the heat in the boiler itself, the results would tend to offset the desirability of the economizer.

A written discussion by Professors Rosencranz and Phillips, of the Oregon Agricultural College, dealt with the control of combustion when burning oil fuel. The authors pointed out that the combustion of oil is practically an instantaneous process, and assuming the ratio of oil to air to be correct with a uniformity of mixture and the proper combustion space, maximum efficiency of combustion will result. An instrument showing the instantaneous rate of flow of the air and oil to the furnace would go far to solve this problem. The $CO_2$ recorder has been a big help in this respect, but it is handicapped by the fact that it is from three to ten minutes late in its indications, which is a disadvantage on variable loads. It was pointed out that the boiler itself could be made its own gas or air meter by attaching a differential draft gage, one end to the combustion space and the other end beyond the last pass. This would measure the boiler resistance, which will be different for every rate of flow, and hence be an indication of the rate of gas flow through the boiler.

Mr. Philip Torchio, in discussing economizers, gave the results of some observations made in Europe about a year ago, to the effect that a considerable saving, probably as high as 8 per cent. in fuel consumption, was possible under certain conditions by the use of economizers. However, the whole equipment of the station must be laid out for such use of economizers. He believed that in this country it would probably be difficult to apply the economizers without changing the auxiliaries and drafts of the boilers, which would make the problem quite expensive. In new stations, however, he believed that economizers could be used profitably by designing them for use with the stacks of the Epozee type, in which air is blown into the stack and creates a draft as in the case of a steam injector. He called attention to the difference between European and American practice, in that the former employed motor-driven auxiliaries almost exclusively.

F. H. Varney, of the Pacific Gas & Electric Co., discussed the use of soda ash in the boilers, his contention being that if air is kept out of the boilers there is no need for soda ash to prevent pitting. For this reason his company has adopted the open type of heaters.

Appended to the Prime Movers' report was a paper by C. M. Allen, which discussed weirs, current meters, pitot tubes, venturi meters, floats, waterwheels and meters, the moving-screen method of measurement, and the salt-solution method. Briefly, the latter method consists of discharging a known amount of salt solution into the water before it passes through the wheel, then analyzing the water as it discharges from the wheel, and from accurate chemical analysis determining the total amount of water discharged by the wheel. Another method was also cited, of injecting color into the conduit close to the forebay and measuring the time elapsed until the color appears in the tailrace.

Professor Peaslee, in discussing Mr. Allen's paper, described a conductivity meter for measuring the flow by the salt-solution method without chemical analysis.

The next paper was entitled "Practice in High-Head Hydraulic Plants," by J. P. Jollyman, of the Pacific Gas & Electric Co., who reviewed the present practice along the Pacific Coast, pointing out that this favors the use of steel pipes with either riveted or welded joints. Expansion is usually provided for by long-radius bends, rather than slip joints, which are employed only where the pressure is not excessive. For heads up to 700 ft. and specific speeds as low as 12, Francis turbines were recommended, and impulse wheels for heads up to 3000 ft. or over, with specific speeds as high as 4 for heads up to 2000 ft. He considered the most desirable speed for waterwheel-driven generators of 3000 to 15,000 capacity to be about 400 r.p.m.

In discussing Mr. Jollyman's paper, M. T. Crawford referred to two 10,000-kw. generators in the White River plant of the Puget Sound Traction, Light & Power Co., which were originally fitted with the usual fan type of rotor for sucking air along the shaft and forcing it out through the windings on the stator. With this equipment the machines carried a rated load with a normal temperature rise of not over 40 deg. C. above the incoming air. It was found, however, that on warm summer days the temperature of the air to the generator room reached as high as 35 deg. C., and any overloading of the machines would give a fairly high temperature in the windings. Accordingly, the generators were inclosed and the incoming air taken from inclosed spaces above the tailrace outside the building. A number of spray nozzles are kept playing in these inclosed spaces, so as to greatly increase the humidity, and the air goes in at a temperature of about 17 deg. C. The generators can now be operated satisfactorily at 40 per cent. overload, and the temperature is cut down to 40 deg. between the laminations and the incoming air.

"Analysis of Waterwheel-Governor Efforts" was the subject of a paper by E. D. Searing. This gave a résumé of an interesting series of experiments made in analyzing a governor problem at one of the hydro-electric plants of the Portland Railway, Light & Power Co. Steam-engine indicators were connected to each end of the governor cylinder of the water-wheel unit, and continuous records of the varying pressures from each side of the governor piston throughout one cycle of operation were obtained. An analysis of the effort of separating friction and unbalance was made, and the rise of pressure in the wheel casing, high pressures in the governor cylinder, overspeed devices and wicket gates themselves, were thoroughly studied.

The next paper was on "Oil-Burning Standby Plants," by C. H. Delany, of the Pacific Gas & Electric Co. This paper will be abstracted in a later issue. In discussing Mr. Delany's paper, E. A. Weymouth mentioned an installation at the plant of the Inspiration Copper Co., in which the boilers are equipped with steel casing and most thoroughly insulated. The boiler efficiency at three-quarters load is higher than at full rating, and at one-half load it is higher than at three-quarter load. This is explained by the fact that radiation is much greater in the case of the ordinary brick setting; and as it is a practically constant quantity for all loads, at light load it will be proportionately greater. The absorption of heat by the heating surfaces is better at light load, but with a brick setting the radiation loss offsets this. With the steel casing, however, and a proportionately less radiation loss, this does not hold true to such an extent, with the result that the efficiency is nearly 2 per cent. better at half load than at full load.

The last paper of this session was by D. M. Downing, on the "Water-Power Development on the Pacific Coast." This gave a general review of the whole subject and was fully illustrated.

### SECOND COMMERCIAL AND ACCOUNTING SESSIONS

The second commercial session, also held on Wednesday morning, took up the report of the Committee on Sales Development in the West, and that of the committee on Merchandising and Recent Development of Electric Appliances. At the second accounting session, an interesting paper on "Workmen's Compensation Insurance" was read by Walter G. Cowles, vice-president of the Travelers Insurance Co. He expressed the opinion that the stock-insurance system is the only one that furnishes reliable means for reducing future losses to present fixed values. "European practice," he said, "along compensation lines, can teach us little or nothing, because the conditions there and here are widely different."

Following this was a paper on "Electric-Vehicle Cost Accounting," by W. P. Kennedy, and another on "Record of Property or Construction Expenditures," by T. R. Ferguson.

### SECOND HYDRO-ELECTRIC AND THIRD TECHNICAL SESSIONS

The hydro-electric and technical sessions were continued on Wednesday afternoon, the order of business including the report of the Committee on Overhead Line Construction, a paper on "Electric Line Distribution in the Pacific Northwestern States," by J. C. Martin, the reports of the Hydro-Electric Sub-Committees on "High-Tension Transmission and Construction," on "High-Tension Apparatus," and on "Main-Line Electrification of Railroads."

On Thursday morning the fourth and concluding technical session took up the report of the Committee on Terminology and that of the Committee on Street Lighting, the latter prepared by J. W. Lieb, of the New York Edison Co., covering a digest of the information made available through an investigation of the street illumination which has been conducted in New York during the past year. M. J. Insull presented the report of the Committee on Accident Prevention, and Mr. Torchio that of the Committee on Underground Construction. The final paper of the session was on "Opportunities of the Public-Service Company in General Accident Prevention," by C. B. Scott, of the Chicago Middle-West Utilities Co.

The third accounting session considered the report of the Committee on Cost Accounting, a paper by O. B. Coldwell on "Analytical Accounting for Central-Station Purposes," and another paper by W. E. Freeman, on "Statistical Machines."

Reports of the Rate Research Committee and the Power Sales Bureau were considered at the fourth commercial session, as well as three papers—"The Commercial Application of Resistance Furnaces," by C. W. Bartlett, "A Stassano Furnace Installation at Redondo," by W. M. McKnight, and "Electric Furnace Power Loads," by F. T. Snyder.

On Thursday evening the Public Policy meeting was held, at which the report of the Public Policy Committee was presented by W. W. Freeman, and addresses were made by Max Thelen, of the Railroad Commission of California, and by John H. Roemer, a former member of the Wisconsin Railroad Commission.

### ENTERTAINMENT FEATURES

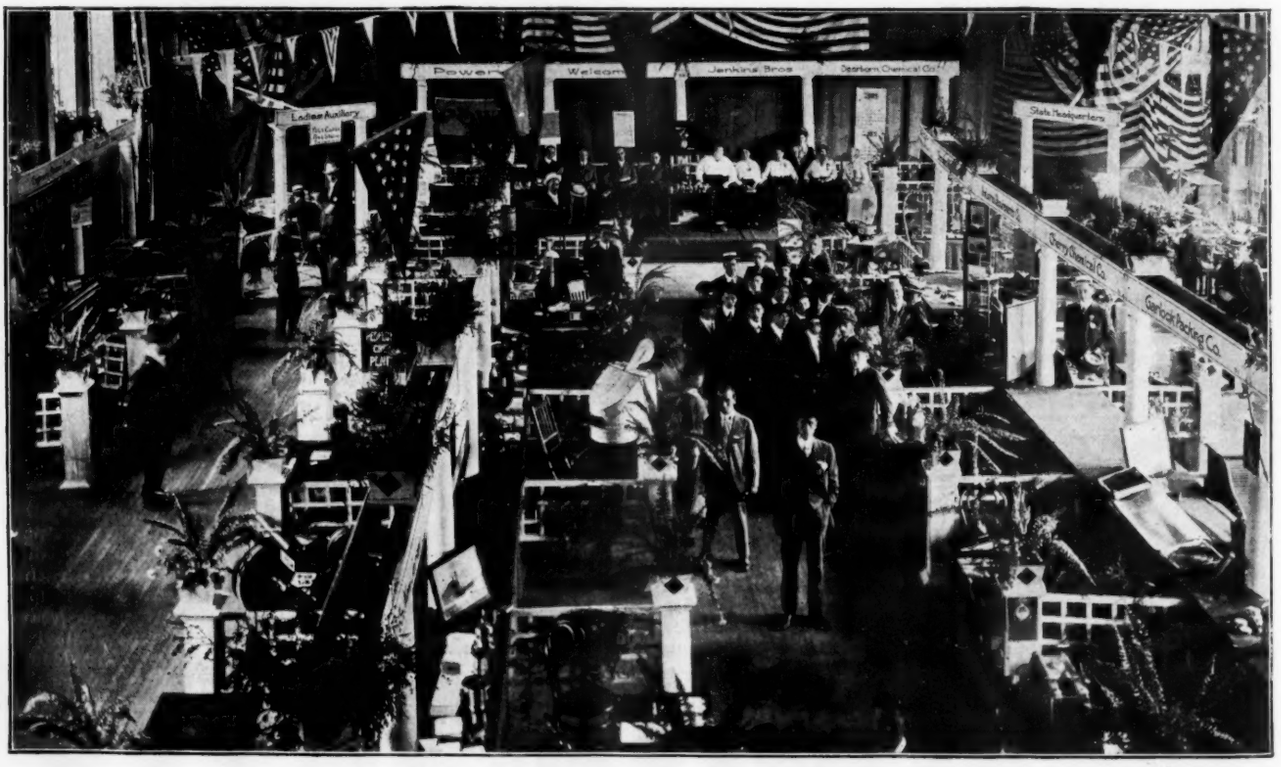
Members of the National Electric Lignt Association attended the Exposition in a body on Thursday afternoon, where a photograph was taken in front of the Tower of Jewels. The ceremonies were held in Festival Hall, and addresses were made by President Moore of the Exposition, President Scott of the Association, Samuel Insull, Arthur Arlett and Mayor Rolph; and greetings were read from Thomas Edison, Alexander Graham Bell, Elihu Thomson, Frank J. Sprague, Charles P. Steinmetz, Charles M. Brush, and J. J. Carthy. President Moore presented President Scott with a bronze medal commemorative of the convention.

The entertainment features also included a musicale and tea for the ladies on Wednesday afternoon, an automobile trip Thursday morning and luncheon at the Cliff House, after which they joined the men at the Exposition in the afternoon. Friday was spent on an all-day sightseeing trip to Mount Tamalpais and the Muir Woods. Special credit is due to F. H. Varney, chairman of the local entertainment committee, for unusual thoughtfulness in providing for the comfort and convenience of the guests.

E. W. Lloyd, general contract agent of the Commonwealth Edison Co. of Chicago, was elected president of the association for the coming year.

## New Jersey N. A. S. E. Convention

While it was generally known that the Trenton convention of the New Jersey N. A. S. E. would consider important association affairs, no announcement had been made that the exhibit was to be one of the best-arranged and attended displays of engineering supplies ever connected with a state convention of the association. The exhibit, held in Masonic Hall, was opened to the public on Thursday, June 3, by Mayor Frederick W. Donnelly, with an address of welcome. A feature of the opening evening was an automobile tour of the




New Jersey N. A. S. E. Convention Exhibit Hall

city "engineered" by the Mayor and Frank V. Tuthill, of the McLeod & Henry Co., and enjoyed by a number of engineers and supplymen.

The business sessions were held June 5 and 6 in the Trenton House, with Charles Sumner, president of the association, in the chair. About a hundred delegates attended. National Vice-President Walter Damon, of Springfield, Mass., and James Taylor, secretary-treasurer of the Life and Accident Department of the association, addressed the delegates during the Saturday session.

The Educational Committee reported that depressed business conditions had caused a slight lull in the educational activity of the various local associations; this was not serious, however, as the state committee had made special efforts to keep the smaller and most-in-need-of-help associations interested, with the result that their educational work on the whole was more commendable than that of the larger associations. The committee expressed the belief that there was no more thorough and inexpensive way of creating educational interest than by question-and-answer contests held by each association. Many associations have received valuable assistance from a pamphlet written by the instructor for Newark No. 3 Association. These "Examination Questions" are to be obtained by addressing No. 3 at 103 Market St., Newark, N. J.

The Legislation Committee handed in a short report at the Sunday session. A. L. Case, chairman of the board of examiners of the State Engine and Boiler Operators' Bureau, pointed out some of the defects in the present license law and read passages from a proposed bill that was vetoed by the governor. The law as it now stands reads that "the provisions of this act shall not be construed to include or apply to men holding marine licenses or to men in plants under the jurisdiction of the United States Government, or to locomotive engineers." Many of these engineers were refused licenses because the attorney-general handed down an opinion that they could not be lawfully given to them. The law needed amending when an engineer holding a license to run a dinky tugboat could operate the largest plant in the state and be immune from any action the license bureau might take. The vetoed bill also provided for a well-deserved increase in the salaries of examiners, from $1200 to $2000 a year. The convention adopted a resolution introduced by Newark No. 3 which embodied the amendments needed in the present law and stated that the governor's veto of the bill was the result of snap judgment. This resolution was ordered printed and circulated.

The next convention of the New Jersey State Association will be held in Paterson, N. J.

Both Joseph Carney and William Reynolds, members of the National Board of Directors, refuted the rumor that the "National Engineer" was subsidized by central-station interests. A resolution was passed and ordered circulated embodying their denials.

Saturday a smoker and cabaret were given by the supplymen under the direction of Frank Martin, of Jenkins Bros., at which, among others, appeared the well-known but always entertaining trio—Jack Armour, Billy Murray and Herbert Self. The new officers elected are: President, Dennis Bartley, of Jersey City; vice-president, Thomas Brown, of Newark; secretary, James S. Heath, reëlected; treasurer, William Krause, of Passaic. During the convention the ladies sold cigars, candy and tags and otherwise added to the pension fund for indigent engineers. Mrs. McCoy, state deputy for the ladies' auxiliary, gave an interesting report of the doings of the state and national bodies.

A list of the exhibitors follows:

Albany Lubricating Co.
Cherry Chemical Co.
Corbett, E. A.
Crew, Levick & Co.
Crook & Son, A M
Dearborn Chemical Co.
Dick, R. & J.
De Laval Steam Turbine Co.
Engineering Supply Co.
Fisher & Norris.
France Packing Cc.
Garlock Packing Co.
Greene, Tweed & Co.
Home Rubber Co.
Homestead Valve Co.
Industrial Requirements Co.
Jenkins Bros.
Johns-Manville Co., H. W.
Keystone Lubricating Co.
Lunkenheimer Co.
McArdle & Co.
McLeod & Henry Co.
Morehead Manufacturing Co.
"National Engineer."
Ohio Blower Co.
Otis Elevator Co.
Peerless Rubber Manufacturing Co.
Philadelphia Grease Co.
"Power."
Quaker City Rubber Co.
Reeves-Cubberley Engine Co.
Clement Restein Co.
Richardson Scale Co.
Robinson Co., W. C.
Roto Co., The
Roebling's Sons Co., John A.
Squires Co., C. E.
Stahl, Harry E.
Standard Regulator Co.
Steam Appliance Co.
Underwood & Co., H. B.
Webb & Sons Co., Elisha.
Zurn Oil Co.

Following the schedule of fittings and flanges published on page 782, June 8, 1915, the address of the National Association of Master Steam and Hot Water Fitters should have been given as 260 West Broadway, New York City.

# Seventh Annual Convention of National District Heating Association

On June 1, 2 and 3, the seventh annual convention of the National District Heating Association was held at the Sherman Hotel, Chicago. The meeting was a great success. The papers and committee reports presented were of a high quality and indicated a vast amount of work in their preparation by practical men engaged in the heating business. The material presented was received with enthusiasm and discussed at length. The association has made wonderful progress since its inception six years ago, and a continuation of the present interest and enthusiasm will insure results of inestimable value to the field of district heating.

On Tuesday morning President H. R. Wetherell called the first session to order. Harry Miller, prosecuting attorney, in behalf of the mayor, welcomed the visitors to the city. The response was made by D. S. Boyden, first vice-president of the association. In his presidential address Mr. Wetherell believed the day had come when steam heating should not be regarded as a byproduct of the electrical end of the plant. It was up to the association to put heating on a paying basis. The public-service commissions of the various states were already insisting that the heating be made independent of the electrical plant so that the low rate formerly made in connection with lighting would be eliminated. By putting customers on a meter basis the consumption of steam would be greatly reduced over the old flat rate and the cost would be lowered to a reasonable figure. It was important to give strict attention to service and in every way possible satisfy the customer.

Secretary Gaskill reported the association in better financial condition than ever before and an increase of 44 members, which was 14.66 per cent. of the membership in 1914. He advised the election of honorary members and recommended that a suitable badge be presented to the retiring president. At the end of the session A. P. Biggs, chairman, presented the report of the station record committee. This dealt principally with franchises. Copies of franchises under which 25 different companies were operating had been obtained and the contents had been spread on a large data sheet, which was available at the convention. A collection and comparison of such data, it was thought, would eventually result in a standard franchise. A table on the steam consumption of various classes of building and the cost of trenching was in course of preparation and would be appended to the report before it appeared in the "Proceedings."

At the opening of the afternoon session J. F. Gilchrist, vice-president of the Commonwealth Edison Co., of Chicago, gave an interesting address on steam heating and the advantages of concentration in the generation of electricity and steam. As heat was one of the requirements of the race, it was evident that the heating business was founded on a solid foundation. It was one of the fundamental things human beings required, and in this respect was a little ahead of its big brother, the lighting and power business. In establishing central heating in Chicago, there had been no special foresight. The company had been forced to it. When they attempted to displace the isolated plant, it became evident that they must know something about the heating business and be in a position to furnish heat. The speaker explained how the Illinois Maintenance Co. had been founded in 1899 and how it had been built up to its present proportions. No comprehensive system had been laid out. It was arranged so that the electric-light contract for a building included the right to operate the plant in the basement to furnish steam for heating and to connect the plant with the piping of the adjoining building. Eventually, the piping was carried across alleys and in some cases streets, so that at the present time there are several plants taking care of a number of buildings. Mr. Gilchrist touched upon the importance of metering the steam, so that it would be to the interest of both the seller and user to minimize the consumption.

Although the possibilities of concentration in the heating business were not so great as in the generation of electric current, the following advantages were enumerated: The reduction of smoke, the possibility of obtaining high-grade labor from which higher economy might be expected, a decrease in the fire hazard and a reduction in the expenditure for handling fuel and ash.

In the United States 517,453,000 tons of coal was consumed per year. Of this amount central stations used 17,375,000 tons, street- and electric-railway plants, 10,078,000 tons; steam railways, 100,000,000 tons; and all other uses, 390,000,000 tons. Electric light and power and street railways only consumed 5 per cent. of the fuel. If the hydro-electric output was reduced to a steam basis this would account for 17,-

000,000 tons, so that the entire electrical output would only require 44,000,000 tons per year, or less than 10 per cent. of the total. The speaker expressed a desire to see a comparison of the work done in the different fields. It was certain that outside of the electric light and power business the coal is burned much less efficiently. Coal for domestic use was estimated at 50 to 100 million tons, leaving the remainder for heating and industrial purposes. By concentration much of this coal could be saved or at least be held to the same figure notwithstanding the increase of population. It was the speaker's opinion that there will in the next few years be a great development in the heating business. The importance of this service in connection with light and power will become greater in the years to come. The distribution of heat was a natural monopoly, and it should be permitted to act as such. It should be made independent of lighting and power and should come under the same regulating bodies as the central-station companies.

### REPORT OF PUBLIC-POLICY COMMITTEE

Recognizing the desirability of all utilities following some form of general policy, the association has a standing committee on this subject. In the report presented the following items were briefly considered: Education of the public as to cost and advantages of heating service, extension, appraisal, rates, municipal ownership, legislation and franchises. The comments were general, leaving it to future years and committees to elaborate and definitely design the policies that should be pursued as conditions change and future developments require.

### UNDERGROUND CONSTRUCTION

At the Wednesday morning session H. A. Woodworth presented the report of the underground construction committee, which was prepared to give the society the benefit of the best practice that the present day affords in the selection of materials and the installation and operation of district heating mains. Letters had been written to various companies affiliated with the association asking for particular data which they possessed. The replies showed a wide variation in the methods used throughout the country, and a study of the data indicated that these variations were not due to the geographical location or climatic conditions. It was clear that one of the greatest needs was a closer attention to standardization. In the report the various items relating to the design, construction and operation of mains were discussed briefly. Most of the data had been drawn from the letters, but other data had been received from outside sources. Items requiring research work, such as the design of high-pressure steam feeders and tests on automatic valves as they affect line capacity, were turned over to authoritative persons to insure accuracy in the results. In an appendix to the paper, descriptions were given of the underground insulations and conduits as they are placed upon the market by the various engineering and manufacturing companies.

### BLEEDER TURBINES

Following an extended discussion on Mr. Woodworth's paper, F. W. Laas read a short paper on operating experiences with bleeder-type turbines. As a preliminary the author related an experience he had had with a 1500-kw. turbine of this type, also an experience with a cross-compound condensing engine supplying steam from the receiver for heating and eventually from the exhaust of the low-pressure cylinder against a maximum pressure of 25 lb. Mr. Laas enumerated the features a successful bleeder turbine should possess, some of the points to be watched in its operation and by means of data from specific cases explained the operating advantages of this type of turbine.

### EDUCATIONAL COMMITTEE REPORT

At the afternoon session Wednesday, D. S. Boyden summarized the report of the educational committee. The work had been divided among the various members of the committee as follows: The establishment of a standard for transmission losses from buildings of all constructions, Reginald Pelham Bolton; the establishment of standard methods of proportioning direct radiation and standard sizes of steam and return mains, James A. Donnelly; the establishment of a standard coefficient for heat losses affected by wind movement, H. W. Whitten and R. C. March; the establishment of standard heating elements for cooking apparatus, with special reference to low-pressure steam, D. S. Boyden.

Mr. Bolton's contribution to the report brought out the wide variation in the hitherto accepted bases of computation. The various transmission losses through building materials were presented in tabulated form, with several suggestions for further observation, which may help to determine these losses definitely.

Mr. Donnelly's report was devoted mainly to the data required in estimating the heat requirements for buildings. It opened with tables of heat losses through building materials, including the losses through various thicknesses of concrete. These were followed by rules for estimating the amount of air required for ventilation. Under transmission from radiating surfaces a useful table was incorporated giving the relative surface in pipe coils and wall radiators. Another table showed the comparative transmission from a standard direct radiator at various steam temperatures. This was followed by a table giving the proportionate amount of radiation required to heat a room to 70 deg. F. from various outside temperatures, with steam in the radiator at 210 deg. F. A feature of many of the tables was that proportional requirements were given for conditions varying from the usual standard of 0 deg. outside and 70 deg. inside. Considerable space was devoted to the operation of gravity hot-water heating systems, vacuum-steam heating systems, forced hot-water heating systems and vacuum-vapor heating plants. In the section devoted to standard sizes of steam mains, a table of steam-pipe sizes based on the Unwin formula was included. Another table gave the comparative carrying capacity of pipes, so that after one size is figured for a certain condition, capacities of all other sizes may be readily obtained. At the conclusion of the report data were given on standard sizes of radiator connections and return mains, with a table showing the standard rating for steam mains as well as the standard for wet returns and for various percentages of steam carried in dry returns, figured for a drop in pressure of 1 oz. to 100 ft. of straight pipe.

A close study of the records of the Public Service Co. of northern Illinois for the past two years, in connection with other data referred to in last year's report, enabled the members of the committee having the work of determining the effect of wind on heating to obtain data from a large group of buildings of varied construction. The constant given last year was modified and now may be used safely, allowing for certain factors which may affect isolated cases.

The report by D. S. Boyden on standard heating elements for low-pressure cooking apparatus was one of progress only. Much remains to be done in this line. The report indicated, however, that apparatus in the kitchen and elsewhere that had formerly operated at pressures of 40 to 60 lb. will do the work satisfactorily on pressures as low as 3 lb. provided the heating elements are properly designed.

### ELECTION OF OFFICERS

The commercial end of the heating business was discussed in a paper by C. F. Oehlman, and immediately after its presentation the election of officers took place, with the following results: D. S. Boyden, president; B. T. Gifford, first vice-president; George W. Martin, second vice-president; W. S. Monroe, third vice-president; D. L. Gaskill, secretary and treasurer; Thomas Donahue and C. F. Oehlman, members of the executive committee.

### HOT-WATER HEATING

At the fifth session, Thursday morning, W. D. Carlton read his paper on "The Hot-Water Heating System at the Grand Central Terminal" in New York City. The paper was brief, giving in outline the arrangement and general construction, some of the operating features and capacities and the method of computing rates for the service.

### REPORT OF STATION-OPERATING COMMITTEE

The report of the station-operating committee was then read by Byron T. Gifford, chairman. It included results of a boiler test conducted along lines suggested by last year's committee; statistics on operating costs, with tabulated results from a number of typical plants; the accounting of operating costs; general information regarding coal, with a table giving the designation, origin and analysis of a great variety of fuel; meters and their uses, including a description of the new Republic flow meter; and miscellaneous points of interest, such as the reason advanced by the New York Steam Co. for softening water that originally contained only 3½ grains of total solids per gallon.

### EXHAUST VS. LIVE STEAM

At the last session of the convention, on Thursday afternoon, C. C. Wilcox read a paper comparing the use of exhaust and of live steam for heating. Tests were conducted on the heating systems of Peoria and Pekin, Ill. From a study of the tests, the following conclusions were derived: The heat consumption for the heating system under similar weather conditions was found to be the same for either live- or exhaust-steam operation; the rate of steam sent to the heating system is increased as the heat content of the steam is diminished; the carrying of an electric load in addition to the heating load cannot be accomplished without an increase in fuel; the main condensation with live steam is less than with exhaust steam; the pressure drop between the station and the end of line is more with exhaust than with live steam,

which may be accounted for by the increased amount of steam delivered to the system; pulsations in pressure caused by the engine exhaust are not propagated very far from the source. A paper by George W. Martin on the same subject was read in abstract as a part of the discussion on the paper by Mr. Wilcox. Mr. Martin stated that it seemed to be the opinion of many engineers that in heating a building with exhaust or live steam a less quantity of the former was required. A number of instances were cited to show that this was not the case, provided the same temperatures were maintained in the rooms and equal attention given to obtaining economical results from the boilers. Investigations in several buildings had disclosed the fact that the bypass for admission of live steam into the heating system had been too small, so that enough steam could not pass through to the system. It gave the impression that the boilers were not large enough to supply the demand. By enlarging the bypass the difficulties were overcome, and the live steam gave as satisfactory service as the exhaust from the engines.

This concluded the papers, some of which will be abstracted more fully in these columns at a later date. Before adjournment the convention discussed the advisability of publishing a quarterly bulletin devoted to association affairs. A unanimous vote gave the board of directors power to act if the proposition was found feasible.

ENTERTAINMENT

Special entertainment for the ladies was provided in the way of a musical and card party, shopping excursions, automobile sightseeing rides, and a lake excursion on the United States training ship "Isle de la Luzon." On Tuesday evening a theater party was attended by all, and on Wednesday evening the banquet, followed by professional entertainment and dancing, was a great success. Fully 160 sat at table and all spent a most enjoyable evening.

EXHIBITS

The exhibits were more numerous than usual and presented an interesting variety of meters, pipe coverings, valves, steam traps and other equipment used in district heating. Following is a list of the firms represented: American District Steam Co., American Radiator Co., Armstrong Cork Co., V. D. Anderson Co., Boylston Steam Specialty Co., Cannelton Sewer Pipe Co., Central Station Steam Co., Consolidated Engineering Co., G. M. Davis Regulator Co., Detroit Lubricator Co., G. T. Hornung, Jenkins Bros., H. W. Johns-Manville Co., Michigan Pipe Co., National Air Cell Covering Co., Republic Flow Meters Co., E. D. Tyler, Westinghouse Electric & Manufacturing Co. and A. Wickoff & Sons Co.

## Worcester Polytechnic Celebrates Fiftieth Anniversary

Fifty years of engineering instruction at the Worcester Polytechnic Institute was fittingly celebrated on June 8 and 9 by exercises preceding the annual commencement, this arrangement affording an opportunity for both undergraduates and alumni to attend and listen to the many prominent engineers and educators who participated.

Starting with a reception by President and Mrs. Hollis at the Bancroft on Tuesday evening, the principal exercises were held on Wednesday morning in Mechanics Hall, the speakers, besides President Hollis, including Governor Walsh of Massachusetts; Doctor Brashear, president of the American Society of Mechanical Engineers; President Lowell of Harvard; and Booker T. Washington, the well-known negro educator. On the platform with the speakers was a large number of delegates from engineering societies and colleges.

President Hollis, in his opening address, sounded a warning against carrying efficiency methods to extremes, claiming that "anyone can understand the application of good sense, good will and system in the mills and factories, but no American can approve any plan that lessens the responsibility of the individual by turning him into a machine."

Doctor Lowell was of the opinion that control over the forces of nature, as gradually worked out by the engineer, had more to do with human prgress, and especially the abolition of slavery, than any change in morals. He pointed out how, in the days of the Roman Empire, the ships were rowed by slaves, but as soon as other and better methods of propulsion were worked out through control of nature's forces, the necessity for these slaves ceased. He cautioned, however, against the misuse of engineering knowledge in lines that would be detrimental to humanity.

The Governor extended to the Institute the congratulations of the State, and was followed by Doctor Brashear, who in his characteristic humorous strain touched upon the human element in engineering work, emphasizing that education should not be for the good of the individual alone, but more particularly to enable one to better aid mankind. Doctor Washington told of the work being done in the negro trade schools with which he is connected in the South.

On Wednesday afternoon the local and visiting members of the American Society of Mechanical Engineers listened to a paper by Professor Alden on the history of the Washburn shops. These shops, in which the students of the Institute receive their practical training, consist of forge, foundry and machine shops and are carried along on a strictly commercial basis, the student working as an apprentice along with a paid journeyman.

In the evening a banquet was held at the Hotel Bancroft, about 600 attending. The speakers included Senator Weeks of Massachusetts; Major-General Wood; Howard Elliott, president of the New York, New Haven & Hartford R.R.; Arthur D. Little, of Boston; Mayor Wright of Worcester; and Francis W. Treadway, ex-lieutenant-governor of Ohio.

## Water-Power Discussion at a Conference of Western Governors

The outstanding feature of the conference of Western governors held in Seattle during May was the discussion on legislation for the use of water power. Those who took part in the conference were the governors of Oregon, Washington, Idaho, Montana, Nevada, Arizona, Utah and Colorado. Governor Carlson, of Colorado, read a paper entitled "Unlocking the West."

That satisfactory results will follow the regulation of water-power sites by the Federal Government rather than the states was questioned by Governor Carlson. He did not favor the adoption of legislation by Congress along the lines of the Ferris bill, which provides that permits for the use of water power situated on government land shall be granted for fifty years, carrying the right of the Government to take over the property at the end of that time at a reasonable price for its physical value.

"We can't trust the state to manage water-power resources as well as we can trust the Government," Governor Boyle said in reply. "States are clamoring now to give away their resources, and while they may pretend to have the door closed, nevertheless their natural resources will be packed out of the windows."

"It is an outrage and shame the way our reasources in Oregon have been managed," said Governor West. "The plan of Secretary Lane for the leasing of water-power sites is a just one. The bill he proposes does not take away any of the sovereign rights of the states. They cannot be taken away by an act of Congress. What is a granted privilege today becomes a vested right tomorrow, and that is why the leasing system is best."

The argument was advanced that the royalty paid to the Government would be borne by the consumers of power and light, as it would be counted by the managers of the hydroelectric projects as a proper item of operating cost.

Governor Carlson outlined his position clearly and forcefully in his paper:

So long as the Department of the Interior revoked power permits only for misuse and nonuse, millions of dollars were put into power plants upon the public domain. The moment this principle was departed from, all development ceased. It is now proposed to remedy the situation by giving permits that will run for fifty years and carrying the right of the Government or the state or municipality to take over the property at the end of the term upon a basis of physical valuation. The plan also proposes to regulate the price of power and to divide the taxes assessed against the property between the Government and the state. For the sake of argument only, conceding the right of the Government to pass such a law, and supposing that it will pass, I do not believe any great development will follow. It is entirely unlikely that investors will put money into projects where no title passes; where the property might be subject to the onerous rules and regulations which thereafter might be promulgated; where there is possibility of conflict between the laws of the state and the rules of the Department of the Interior.

Investors are not likely to take kindly to a plan that would keep a property upon their hands if the venture be a losing one, or that might be taken from them if it proved a profitable one. The power of eminent domain inherent in every sovereign state has been used again and again when it has been found necessary to beneficially use the waters of a stream. Private property has always been subject to the exercise of this power by the state or delegated agents, and the only theory that would prevent its exercise by the states upon government lands is that such are not held by the Government in a private proprietary capacity, but as a superior sovereign power within a sovereign state. There is not a line in the Federal Constitution giving the Government a right to set up an independent sovereignty within the borders of a state, and I believe the time is not far distant when Congress will pass legislation declaring the inherent rights of Western states. Our greatest obstacle at the present

time is to bring the East to our view. This is not as difficult as it was ten years ago. The multiplication of cases where millions of dollars of capital were planned to be expended in Western states for the development of its low-grade ores, of lighting plants, power plants, interurban lines, irrigation projects, etc., that have been diverted to Mexico, Bolivia and other foreign countries will strike home sooner or later to the Eastern manufacturer, and he will undergo the inevitable disillusionment of the enchanting theories of the ultra-conservationist.

"I think the policy of the Government holding title and leasing power sites to individuals, giving them only temporary control, is opposed to the best interests of the states," said former Governor Hawley, and he recited several cases that have gone to the highest courts of the land, upholding the sovereign power of the states in the management of their resources.

The conference, however, before its adjournment did not come to a definite agreement on legislation for the use of water power, as it was the sentiment to postpone action until the water-power conference to be held in Portland, Ore., Sept. 21-23, which the governors will attend. This question is also expected to be one of the leading features of the national conference of governors of the country to be held the last week in August, at Boston, Mass.

## Rating of Diesel Engines

In the course of a lecture before the Junior Institution of Engineers, W. A. Tookey, the well-known English authority on internal-combustion engines, referred to the high rates asked for insurance against breakdowns of Diesel engines and to the occurrences reported from time to time in the technical press, in which broken crankshafts, seized pistons and similarly serious accidents are mentioned. These occurrences, he thought, proceeded mainly from the overstressing of cranks and the excessive heating of pistons, due to a prevalent tendency to over-rate the permissible output from given cylinder dimensions. He was inclined to lay the blame, not upon the technical men responsible for the details of construction, but upon those who are intrusted with the negotiations with prospective purchasers and who are particularly interested in claiming as small a ratio as possible between horsepower developed and initial cost. Cases had occurred in which lack of appreciation of this point had led to the engines working overloaded, or where it was found necessary to reduce the load originally contemplated, in order to avoid risk of breakdowns. Thus it had happened in a number of cases that the Diesel engine had not enjoyed the reputation that its high thermal efficiency and general reliability so amply merited when properly selected, erected and maintained.

Proceeding further to discuss this phase of the subject, the speaker pointed out that while the limit of power in an internal-combustion engine cylinder is definitely established and recognized, the rating of electrical machinery is purely arbitrary and apparently, therefore, much more elastic. Experience had dictated that a "rated" output about 10 per cent. below the permissible maximum, or overload rating of Diesel engines, is satisfactory and convenient. In smaller cylinders this could be based on a higher mean pressure than is advisable with cylinders of larger sizes.

He concluded with references to the manipulation of details in starting, running and stopping, and many valuable practical hints were given in this connection, both for single- and multi-cylinder engines. Particular emphasis was laid upon the paramount importance of scrupulous cleanliness and conscientious management, a matter which depends quite as much upon the personal attribute of the attendant as upon his technical ability.

## OBITUARY

### CLAUDE H. HUNTINGTON

Claude H. Huntington died May 21 after a brief illness. At the time of his death he was president of St. Louis Association No. 2, National Association of Stationary Engineers.

### HARRY H. WHEELER

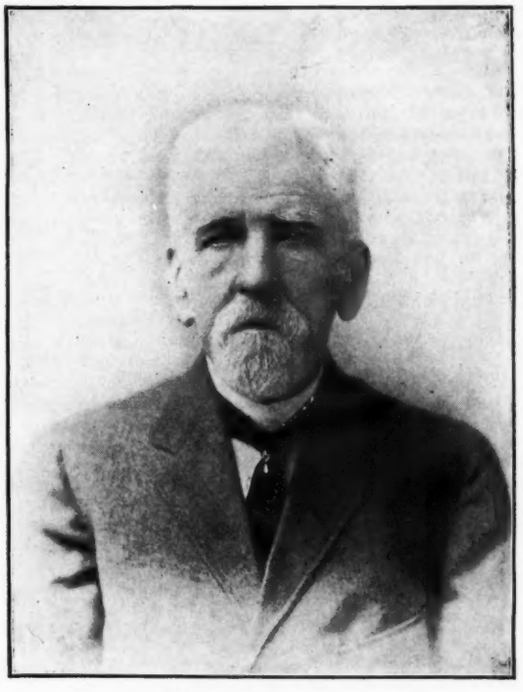
Harry H. Wheeler, of St. Louis, Mo., died suddenly on June 2, from injuries received in an automobile accident. He was a past-president of St. Louis Association, No. 2, N. A. S. E., and was a brother of William Wheeler, of New York, a Past-National President of the organization. About twenty-five years ago he left New York City to make his home in St. Louis. He is survived by a widow and three daughters.

### JOHN F. FARLEY

John F. Farley, who died June 6 in Brooklyn, had for many years been employed as an engineer in the Department of Water Supply, Gas and Electricity of the City of New York, and for the last four years had been with the Department of Sewers. He was a member of the N. A. S. E. and the International Union of Steam Engineers.

### WILLIAM NAYLOR

William Naylor died June 13 in Chicago at the age of 83. He was born in Lancashire, England, and seven years later began work operating hand machines in a calico-printing mill. He was apprenticed as machinist's assistant in the railroad shops at Bradford at the age of 9 and worked continuously until he retired last year. After serving several years as a locomotive driver on roads running between Yorkshire and Liverpool, he left England in the fall of 1858, and reached America by way of New Orleans, after a voyage of seven weeks on a combination steam and sailing vessel. He came by boat up the Mississippi and Ohio Rivers, and was employed as a sawmill operator and flour-mill engineer in Wabash County, Illinois. At the close of the Civil War he moved to



WILLIAM NAYLOR

Missouri, and in 1866 to Chicago. He worked as engineer in flouring mills until 1871, when he engaged with Field, Leiter & Co., now Marshall Field & Co. In those days the engineer and one fireman were able to easily take care of all the machinery of the corporation which today has 20 or 30 buildings and 250 men in the various engine departments. Mr. Naylor's long and faithful service was fully appreciated by the Marshall Field Co., which retired him last year on a handsome pension. He was a member of the National Association of Stationary Engineers since 1890, treasurer of the Robert Fulton Association continuously for 22 years, and was also a member of the Chicago Steam Engineers' Club. He was married to Ann Haigh before he left England and was the father of Charles William Naylor, Past National President, N. A. S. E. It was said that he was a friend of almost every operating steam engineer in and about the city of Chicago.

### CHARLES E. CHINNOCK

Charles E. Chinnock, a manufacturer of telegraph instruments and one of the pioneers of the electric-light and telephone industries, died June 11 in Brooklyn, N. Y., in his seventieth year. When the telephone and electric light were still in their infancy he became associated with Thomas A. Edison, was later the superintendent of the first central station of the New York Edison Co., and as the vice-president of the Edison United Manufacturing Co., the parent Edison company, he was largely responsible for the founding of the Edison Electric Illuminating Co. of Brooklyn. The Edison United Manufacturing Co. was merged with the Thomson-Houston Co., which afterward became part of the General Electric Co. Mr. Chinnock was also chief electrician of the Metropolitan

Telephone Co., now the New York Telephone Co., and he patented many electrical inventions, among them an automatic transmitter, for teaching telegraphy that was adopted by the U. S. Government. Another of his inventions used by all the telephone and telegraph companies is a method of suspending aërial cables.

AUSTIN LORD BOWMAN

Austin Lord Bowman, one of the foremost bridge builders and engineers in this country, died June 3, at his home in New York City He was born in Manchester, N. H., in 1861, and studied engineering at Yale, graduating in 1883. He engaged in engineering work continuously until the time of his death, specializing in design and heavy construction in both railroad and bridge work. Of his more important work, the construction of the Kings County Elevated Railroad in Brooklyn, his service as engineer in charge of construction for the American Bridge & Iron Co., and his reconstruction of the bridges on the Central Railroad of New Jersey are especially worthy of mention. He was made a member of the American Society of Mechanical Engineers in 1899 and was also a member of a number of other engineering societies. In 1907 he entered the service of New York City as consulting engineer of the Bridge Department, and in a few years was made chief engineer of the department, the position he held at his death. Commissioner Kracke, of the Bridge Department, and the chiefs of thirty departments under him, drew up suitable resolutions expressing their condolence, which will be embossed on parchment and presented to the family of their associate.

## PERSONALS

S. H. Viall, assistant chief of the Chicago smoke department, has severed his connections with the city and is open for engagement.

Robert H. Kuss has severed his connections as sales engineer with the Edge Moor Iron Co. and will devote his time to advisory engineering.

J. A. Carson, better known as "Jack" Carson, formerly with the Durabla Manufacturing Co., is now connected with the Home Rubber Co., Trenton, N. J.

Hill & Ferguson, consulting engineers, 100 William St., New York City, have opened a laboratory for analyzing water and chemicals used in water treatment, as well as coal, oils and boiler compounds, and for testing the calorific value of coal.

S. F. Jeter has been appointed chief engineer of the Hartford Steam Boiler Inspection and Insurance Co. This is a recently created office, the holder to have general charge of the mechanical work for the company. Mr. Jeter for the past four years has held the position of supervising inspector in charge of the inspection service of the company.

## ENGINEERING AFFAIRS

**The Connecticut State Association** of the N. A. S. E. will hold its annual convention at Hartford, on Friday and Saturday, June 25 and 26. The Engineers' Committee, assisted by the officers of the Supply Men's Association, has about completed the final arrangements, and a successful meeting is looked forward to.

**The American Society of Refrigerating Engineers** will hold its fourth Western meeting at San Francisco on Sept. 23 and 24. A special train, leaving Chicago Sept. 15 and arriving in San Francisco Sept. 21, has been arranged for the members, their families, and friends. Those attending the meeting will have the opportunity of attending the International Engineering Congress, which takes place from Sept. 20 to 25. Details of the trip may be obtained from the secretary of the association, W. H. Ross, 154 Nassau St., New York City.

**The American Railway Master Mechanics' Association** held its 48th annual convention, June 9-11, at Atlantic City, N. J. During the sessions committee reports were presented relating to locomotive stokers, smoke prevention, locomotive boilers, fuel economy and boiler washing. The Committee on Locomotive Stokers reported that the device was withstanding the test of continuous service with remarkable durability. Nothing novel has been presented during the past year, but a great deal of good work has been done in redesigning and improving detailed parts to better withstand the service. Data gathered from the scatter-type stokers in more extensive use show that the cost per 100 miles ranges from 43 to 68c., and the miles run per failure from 1000 to 5000. The committee felt unable to point to any rule in terms of weight of engine or train load, or to general conditions where the stoker will always be applicable or necessary. This is owing to the wide range in physical and operating conditions and in the character and price of fuel. According to the Committee on Smoke Prevention, continued use of the steam-air jets and quick-action blowers has further demonstrated that locomotives thus equipped may be kept comparatively free from smoke, provided the engine crews are properly instructed and carry out such instructions at all times. The report also presents a brief description of the Joint Smoke Inspection Bureau of the railroads operating in Chicago, and states that the record books of the City Smoke Department show a reduction in density of railroad smoke from 22% in 1910 to 7% in 1914. The committee on locomotive boilers recommended rules for determining stresses in such apparatus. These rules are the result of an analysis of existing practice of a number of representative railroads and locomotive builders. Since fuel economy depends not only upon the use of locomotives designed to have maximum efficiency, but to a large extent on their proper operation, the Committee on Fuel Economy presented a standard manual of instruction for enginemen and firemen. It is intended that this manual, while embodying all the essential points of efficient locomotive operation, should be brief and free from technical data. Superheaters, properly maintained and efficiently operated, are by far the most valuable mechanical aid to fuel economy ever applied to locomotives, and by their use savings of from 20 to 25 per cent. in coal and water are obtainable. The committee believed that to obtain the best results from the superheater a temperature indicator is desirable. The Committee on Boiler Washing gave an outline of the general practice of washing locomotive boilers. Many railroads have found that the use of hot water for boiler washing results in a saving of time, water and fuel. Chemical means of preventing incrustation are largely used. The chemicals are placed either in engine or wayside tanks, preferably the latter. The use of water-softening plants has resulted in an average increase in mileage between flue-setting and boiler repairs of over 100 per cent. In a paper on "Variable Exhaust," J. Snowden Bell stated that while these devices have effected an economy in fuel, none has proved sufficiently satisfactory or desirable, and it is not believed there are any at present in railroad service in the United States. In Europe, however, the early introduction of the variable exhaust has been followed by its general application. As an appliance designed to operate in the direction of economy of fuel, the variable exhaust merits careful consideration. If this be given, no doubt a variable exhaust can be produced to satisfy the requirements; that is to say, it would be properly constructed, automatically operable and fool-proof because independent of the human factor.

## NEW PUBLICATIONS

DYNAMOMETERS. By F. J. Jervis-Smith and Charles V. Boys. D. Van Nostrand Co., New York. Cloth, 267 pages; 5½x9 in.; 119 illustrations. Price, $3.50.

DISTRICT HEATING. By S. Morgan Bushnell and Fred B. Orr. Heating and Ventilating Magazine Co., New York. Cloth, 290 pages; 6x9¼ in.; 82 illustrations; tables. Price, $3.

LOCATION OF CARBURETION TROUBLES MADE EASY. Chart arranged by Victor W. Page. Published by the Norman W. Henley Publishing Co., New York, 1915. Price 25c.

A plate showing a typical gasoline system as applied to an automobile motor, with a section through the carburetor. Motor troubles traceable to poor carburetion are diagnosed and the remedies prescribed; also general directions are included for the adjustment of carburetors. The automobilist will find the chart very useful.

HANDBOOK OF MACHINE SHOP MANAGEMENT. By John H. Van Deventer. Published by the McGraw-Hill Book Co., New York. Cloth, 374 pages; 4x6¾ in.; 244 illustrations. Price, $2.50.

This book is a careful effort to collect the best available information and data upon the details of management and to present them in concise form for the convenience of managers of machine shops and similar undertakings. To use the author's analogy, the book bears the same relation to those treating of systems of management that a book giving the fundamental data bears to books on the general theory of machine design. There is little that is speculative, and the information for the most part relates to data and elements

of management that have been tested in actual practice. The book is arranged in handbook form, with seven sections. Under Section I are collected material and data on organization and system. Details pertaining to drafting-room systems, standardization of drawings and filing methods are given in Section II. The information in Section III relates mainly to the selection and installation of equipment, while Section IV contains data on shop and production orders and methods. Section V deals with timekeeping, payroll methods and cost-keeping. In Section VI are given data on shipping, transportation and tracing methods. In the last section information on safety mechanism, fire prevention and sanitation is given. While the beginner will find much of interest and profit in the book, because of the necessarily abbreviated treatment it will prove of more value to those who have already given some attention to these matters, and who can therefore use discrimination in selecting material.

EL INGENIERO Y CONTRATISTA

The title given applies to a new Spanish engineering periodical, the first number of which was issued in June. While the publication is begun in a small way, it is hoped to make it really useful in advancing the interests of American engineering practice in Spanish-America. It is published by Dodwell & Co., Ltd., 135 Front St., New York City.

## TRADE CATALOGS

McNab & Harlin Mfg. Co., 55 John St., New York. Bulletin. Regrinding valves. Illustrated, 20 pp., 5x7 in.

Scranton Pump Co., Scranton, Penn. Bulletin No. 102. Duplex plunger pumps. Illustrated, 12 pp., 6x9 in.

Link-Belt Co., Philadelphia, Penn. Bulletin No. 221. Circular storage system for storing coal, etc. Illustrated, 4 pp., 6x9 in.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin No. 34-U. Instructions for installing and operating Class N-SP fuel oil driven compressors. Illustrated, 24 pp., 6x9 in.

Elliott Co., 6910 Susquehanna St., Pittsburgh, Penn. Bulletin L. Reducing valves. Illustrated, 8 pp., 6½x10 in. Bulletin M. Balanced valves. Illustrated, 4 pp., 6½x10 in. Gifford-Wood Co., Hudson, N. Y. Bulletin No. 17. Pivoted bucket carrier for conveying coal, ashes, etc. Illustrated, 16 pp., 6x9 in. Bulletin No. 18. Adjustable car loader for handling ice, house ice cutter. Illustrated, 8 pp., 6x8 in.

## BUSINESS ITEMS

The Sullivan Machinery Co., Peoples Gas Building, Chicago, Ill., has moved its Boston office from 35 Federal St., to Room 1010, Unity Building, 185 Devonshire St.

The Kern Commercial Co., 114 Liberty St., New York, has received an inquiry from a client in Scandinavia for various steam specialties, such as lubricating apparatus and cups, injectors, valves, manometers, etc. The company is inviting figures.

The Terry Steam Turbine Co., Hartford, Conn., has appointed Joseph Battles as district sales manager for Denver, covering States of New Mexico, Colorado, Wyoming and the western portion of Nebraska. Mr. Battle's address is 326 First National Bank Building, Denver, Colo.

The McIntosh & Seymour Corporation, Auburn, New York, has appointed V. E. Raggio, 1107 Nevada St., El Paso, Texas, to represent the company in Arizona, New Mexico, Texas west of a line drawn north and south through Del Rio, and the States of Sinaloa, Sonora, Chihuahua, and Durango, in Old Mexico.

The Ingersoll Rand Co., 11 Broadway, New York, has recently issued a catalog, form 3031, descriptive of the new "Ingersoll-Rogler" Class "FR-1" Steam Driven Single Stage Straight Line Air Compressors. The catalog is profusely illustrated showing the details of the machine in section and is sent on application.

**Ice Making Plants in the U. S.**—We are advised by the editor of "Ice and Refrigeration" that the number of ice-making plants in the United States is not 12,500, as given on page 659 of our May 11 issue, but 4245, as given in the "Ice and Refrigeration Blue Book."

**The World Bestows Big Prizes,** both in money and honors, but for one thing. And that is initiative. Initiative is doing the right thing without being told; but next to doing the thing without being told is to do it when you are told once. Next, there are those who never do a thing until they are told twice: such get no honors and small pay. Next, there are those who do the right thing only when necessity kicks them from behind, and these get indifference instead of honors, and a pittance for pay.—Elbert Hubbard.

## NEW EQUIPMENT

### ATLANTIC COAST STATES

It is reported that the Athol Gas & Electric Co., Athol, Mass., contemplates extending its transmission lines to Petersham, Mass., if sufficient business is guaranteed. The estimated cost of building the line and installing the distribution system is from $10,000 to $15,000. George MacKnight, Athol, is Supt. and Ch. Engr.

The City Council of West Newbury, Mass., is considering the installation of a municipal electric-lighting system. The present service is furnished by the Newburyport Gas & Electric Co.

It is reported that the City Council of Lindenhurst, N. Y., is considering the installation of an electric-light plant in connection with the municipal water-works system.

The Diamond Match Co., Oswego, N. Y., has awarded the contract for the construction of its new power house in Oswego. The equipment will include two 500-hp. boilers (with space for a third one of the same size) and two 1000-kw. generators. The boilers will be equipped with automatic stokers.

### SOUTHERN STATES

It is reported that contracts will soon be awarded by the Town Council of Dayton, Va., for the installation of a municipal electric-light plant. Bonds to the amount of $24,500 were recently sold for this purpose and the construction of a sewer system.

The People's Light, Heat & Power Corporation, Westpoint, Va., contemplates the construction of an addition to its plant and the installation of another unit. Samuel MacWatters is Supt.

The City of Hertford, N. C., is considering a bond issue of $12,000, the proceeds of which will be used for the installation of a municipal electric-light plant.

The City of Warsaw, N. C., has granted a franchise to Oliver Pettit, Clinton, N. C., for the installation and operation of an electric-light plant.

Plans are being prepared for the construction of a municipal electric-light plant at Ocala, Fla., estimated to cost $75,000. H. C. Sistrunk is City Clk. Twombly & Henney, 55 Liberty St., New York, N. Y., is Engr.

The City of White Castle, La., will install a municipal electric-light plant to cost about $25,000. Xavier A. Kramer, Magnolia, Miss., is Engr.

It is reported that E. B. Jones and John E. Green are interested in the establishment of an electric-light plant at Crossville, Tenn.

It is reported that E. H. Crump, Mayor of Memphis, Tenn., is agitating a project to build or buy a municipal electric-light plant. A bond issue of $1,500,000 is said to be available for the purpose.

The Commercial Club of Harlan, Ky., is reported to be promoting the establishment of a $250,000 electric plant in Harlan, to be built by an association of Cincinnati capitalists.

### CENTRAL STATES

It is reported that the Canton Electric Co., Canton, Ohio, has purchased a site for the construction of an addition to its power station. The company has authorized improvements to its system to cost about $250,000. W. C. Anderson, Canton, is Mgr. and Supt.

The Board of Education of Cincinnati, Ohio, Charles Handman, Business Mgr., has engaged an engineer to prepare plans and estimates of the cost of installing electric generating stations in a number of the larger schooi buildings of the city.

A special election will be held June 22 at Painesville, Ohio, to vote on the question of issuing $35,000 in bonds for the purpose of improving the municipal electric-light plant.

The Ohio Light & Power Co., Tiffin, Ohio, has made application to the City Council of Granville, Ohio, for a franchise to supply electricity for domestic and commercial purposes in the latter place.

C. C. Outland, Mayor of Zanesfield, Ohio, and E. Huntzinger, Piqua, are preparing to organize a company to install and operate an electric-light plant in Zanesfield.

It is reported that the Mohawk Mining Co., Calumet, Mich., plans to install an electric-light and power plant.

### WEST OF THE MISSISSIPPI

According to press reports, bids will soon be asked for the installation of a municipal electric-light plant in Davenport, Neb. Charles F. Sturtevant, Holdredge, Neb., is Consult. Engr.

At a recent special election in Tekamah, Neb., the citizens voted to issue $15,000 in bonds to be used for extending the municipal electric-light plant to furnish 24-hr. service. M. S. McGrew is Secy. and Cont. Agt. of the plant.

It is reported that arrangements are being made for the installation of an electric-light plant in Michigan, N. D.

The Town of Chilhowee, Mo., has voted a bond issue of $6800 to be used for the installation of a municipal electric-light plant.

It is reported that W. B. Rollins & Co., Midland Bldg., Kansas City, Mo., is preparing preliminary plans for the installation of a municipal electric-light plant at Harrisonville, Mo. The estimated cost is $15,000.

It is reported that the Sterling Consolidated Electric Co., Sterling, Colo., will shortly install a 250-kw., three-phase, 60-cycle, 2200-volt generator and engine. The company will purchase stokers for three boilers, poles and wire. H. L. Titus is Mgr.